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Pritchard, A.

A history of infusoria . . .

London, 1842

A

HISTORY

OF

INFUSORIA,

LIVING AND FOSSIL:

ARRANGED

ACCORDING TO "DIE INFUSIONSTHIERCHEN" OF C. G. EHRENBERG;

CONTAINING

COLOURED ENGRAVINGS, ILLUSTRATIVE OF ALL THE GENERA, AND DESCRIPTIONS OF ALL THE SPECIES IN THAT WORK, WITH SEVERAL NEW ONES.

TO WHICH IS APPENDED

AN ACCOUNT OF THOSE RECENTLY DISCOVERED IN THE CHALK FORMATIONS.

BY ANDREW PRITCHARD, M.R.I.,

AUTHOR OF "MICROSCOPIC ILLUSTRATIONS," "NATURAL HISTORY OF ANIMALCULES,"

&c. &c. &c.

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PREFACE.

In the spring of 1834 the *Natural History of Animalcules* was published. The design of that work may be seen in the following extract from its pages :—

"Where can you refer me to a description of Animalcules? What magnifying powers are the best to view them with? What are their comparative sizes? I have found a very curious creature, of such and such a form, is it known? Where can I obtain drawings of such as are known? &c. &c. I have ventured to take a general survey of the subject, and the more willingly, because at present no similar work exists, unless it be that of Adams, published in 1787, which contains only a very slight account of the external characters of such as were known in his time, without giving any admeasurement of their size, or sufficient figures to render it generally useful; while its price is such as to place it beyond the reach of many persons."

The *Natural History of Animalcules* is now out of print; a Second Edition would have appeared, but the

favourable reception of the first has induced me to prepare the present manual, conceiving greater benefit would accrue to science by reconstructing it, and introducing the discoveries made since that time, than by a mere reprint.

Dr. Ehrenberg's magnificent and elaborate work, entitled *Die Infusionsthierchen*, having since appeared, and offering a better classification than Müller's, it has been adopted here. I have only to regret that its distinguished Author, or some more competent Naturalist than myself, has not presented us with an epitome of it.

In the description of the families, genera, and species, I have not adhered to *Die Infusionsthierchen*, but only condensed such portions as appeared desirable, interweaving them with other matter: hence it would be unjust to its Author to consider this manual an abstract of it. That work being intended to establish a new classification, and as a book of reference, a large portion of its ample 600 folio pages is occupied in giving the synonyms, in references, and in discussions; these I have omitted, but every species described in that work will be found here, together with many others since discovered.

A new system of classification is seldom acceded to

wholly at first: that by Dr. Ehrenberg has met with its share of opponents. The principal arguments respecting it will be found herein; so that the student, having both sides of the question before him, will be able to arrive at a fair conclusion.

The translation of *Die Infusionsthierchen* was made for me by Dr. Willshire; that excellent botanist has also compared my manuscript of Part II. with that work, so that the materials taken therefrom are, no doubt, correctly given. Since Dr. E.'s volume appeared, some discoveries in Fossil Infusoria have been made; these, and the Spermatozoa of plants, unknown in this country, I have introduced. Information derived from other sources is duly acknowledged.

A few words seem necessary regarding the drawings. Those for *plate* xii. were kindly furnished me by that venerable and distinguished botanist, Dr. Unger, of Gratz, and the late eminent microscopic observer, Mr. F. Bauer. Every original drawing has the artist's name mentioned in the description of it, and the others, with few alterations, are from *Die Infusionsthierchen.* The labour and time occupied in selecting, reducing, arranging, and condensing these, was far greater than most persons would imagine, and has been augmented by the discovery, after some

were finished, that the arrangement of Dr. E.'s figures did not agree with his text: thus, even species are sometimes widely separated, and creatures figured under one name are described under another; so that, in some cases, the drawings had to be made three times.

In conclusion, the labour and cost of this undertaking has far exceeded my anticipation; but should it meet with patronage sufficient to repay the outlay, and my health permit, it is my intention to bring out, on another branch of Microscopic Science, a work of equal extent to the present, materials for which I have been for some time collecting.

London, 162, *Fleet-street;*
18*th March*, 1841.

Postscript.—Since the above was written, Dr. Ehrenberg's work on Infusoria found in the Chalk Formations, published at Berlin, has appeared; and, in order to bring the subject down to the present time, I have inserted an abstract of it in an Appendix.

June, 1841.

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PART I.

GENERAL HISTORY

OF

INFUSORIAL ANIMALCULES.

Among the arguments deducible from the natural world, in support of the existence and superintending Providence of an Almighty Intelligence, none can carry a stronger conviction home to a reasoning and philosophic mind, than those which are drawn from that portion of it which falls under consideration in the present treatise. Interspersed throughout this world of nature, designed and formed by a gracious and All-wise Creator—if, with no other intention, still, with that of yielding evidence indisputable of His own Omnipotence—exists a world within a world, of beings so diminitive, as to have provoked man's utmost ingenuity to bring them within the range of his perceptive powers.

"In the clearest waters, and also in the troubled, strongly acid, and salt fluids of the various zones of the earth; in springs, rivers, lakes, and seas; in the internal moisture of living plants and animal bodies, and, probably, at times, carried about in the vapour and dust of the whole atmosphere of the earth, exists a world, by the common senses of mankind unperceived, of very minute living beings, which have been called, for the last seventy years, INFUSORIA. In the ordinary pursuits of life, this mysterious and infinite kingdom of living creatures is passed by without our knowledge of, or interest in, its wonders. But, to the quiet observer, how astonishing do these become, when he brings to his aid those optical powers by which his faculty of vision is so much strengthened. In every drop of dirty stagnant water, we are generally, if not always, able to perceive, by means of the microscope, moving bodies, of from 1-1150th to 1-25,000th of an inch in diameter; and which often live packed together so closely, that the space between each individual scarcely equals that of their diameter."

The wisdom and goodness of Providence have endowed these living creatures with all that can be needed for their happy existence. A reference to the drawings, generally, will afford some idea of their beautiful and varied forms. What, for instance, can be more admirable in structure than the Infusoria of the family Volvocina? (See *Plate* I. *figs.* 34 to 57.) In what class of animals are its members so curiously and so symetrically associated together? In the Volvocina, innumerable beings are colonized within a simple, delicate, crystal-like shell, whose form, sometimes spherical, at others quadrangular, presents us with

examples of perfect harmony and proportion. Who can behold these hollow living globes, revolving and disporting themselves in their native element, with as much liberty and pleasure as the mightiest monster of the deep:—and, to carry our views a step further, to speak in detail of series of globes, one within another, alike inhabited, and their occupants alike participating in the same enjoyment —who can behold such evidences of creative wisdom, and not exclaim with the Psalmist, "How wonderful are thy works, O Lord, *sought out* of all them that have *pleasure therein!*"

Again, take an example from the *most minute* of living beings to which our knowledge at present extends, such as the Monas crepusculum (see Part II.), and compute the number which could occupy the bulk of a single grain of mustard seed, the diameter of which does not exceed the tenth of an inch: it is hardly conceivable that within that narrow space *eight millions* of active living creatures can exist, all richly endowed with the organs and faculties (as hereinafter fully described) of animal life! Such, however, is the astonishing fact. Again, to take an example from those families of Infusoria, who posses the power of *changing their forms* at pleasure, and yet confine it to the drawings of the first plate (although the second would furnish *protean* phenomena of a more extraordinary character), take the figures of the family Astasiæa (*groups* 68 to 82), and you have creatures capable of assuming all the various forms there depicted, in the short interval of a few seconds, and that under the observer's eye. In the beautiful little creatures of the genus Euglena, you may also perceive a distinct *visual organ,* by which they can

steer their course with unerring rectitude. Many of the Infusoria do not possess this organ. But, mark the all-wise dispensation of Providence in this respect!—those which have it live, for the most part, near the surface of the water, whilst those which have it not, as the Bacillaria, locate near the bottom. This circumstance in their economy has not hitherto been noticed.

Lastly,—still restricting our observations to the drawings of the first plate, look at the graceful forms of the small family Closterina (*fig.* 63 to *group* 67), which have long rivetted the attention of the most eminent naturalists of modern times, and which have hitherto defied all their powers of investigation, aided by all the refined and searching means which human ingenuity can supply, to determine whether they are animals or plants! No characteristic, at present known, has been found sufficient to satisfy both the zoologist and botanist.

In short, there is not one species, out of the seven hundred and thirty-two described in the second part of this work, but offers ample scope for the exercise of our deepest reflection, at the same time that it affords an admirable proof of the adaptation and design of Creative Wisdom.

For the convenience of reference, it is proposed to divide this part into sections; and, although the subjects treated of may not, as respects some few of them, have received all that careful investigation which they deserve, yet it is presumed that sufficient has been done to lead the minds of the more curious inquirer to a further research. Previous to which, I present the reader with Dr. Ehrenberg's summary of the subject:—

1. All the Infusoria are organized, and the greater part of them (probably all) are *highly* organized bodies.

2. The Infusoria constitute two very natural classes of animals, according to their structure, which classes admit of subdivision, upon the same principle.

3. The existence of the Infusoria in the four quarters of the globe, and the sea, is proved; as also that of individuals of the same species in the most opposite ends of the world.

4. The geographical distribution of the Infusoria upon the earth follows the laws observed regulating that of other natural bodies.

5. Most of the Infusoria are invisible to the naked eye; many are visible as moving points; and the size of the body does not exceed, in any case, the 1-12th of an inch.

6. The minute invisible Infusoria, in consequence of their immense and swarming numbers, colour large tracts of water with very remarkable hues.

7. They give rise to one kind of phosphorescence of the sea, though in themselves invisible.

8. They compose (though singly invisible) a sort of mould, through living in dense and crowded masses.

9. In a cubic inch of this mould, more than 41,000 millions of single animals exist, and constitute, most likely, the chief proportion of living bodies upon the face of the earth.

10. The Infusoria are the most reproductive of organised bodies.

11. From one of the known propagative modes of the Infusoria—that is, of self-division—a continual destruction, beyond all idea, of the individual, and a similar inter-

minable preservation and extension of it, in air and water, ensues, which, poetically, borders upon eternal life and growth.

12. The copulation of gemmæ, which perhaps includes the hitherto unsolved poly-embryonate riddle of the seeds of all plants and vegetable formations, is solved in the family Closterina.

13. The Infusoria, in consequence of their siliceous shells, form indestructible earths, stone, and rocky masses.

14. With lime and soda we can prepare glass, and swimming bricks, out of invisible animalcules; use them as flints; probably prepare iron from them; and use the *mountain meal*, composed of them, as food in hunger.

15. The invisible Infusoria are sometimes hurtful, by causing the death of fish in ponds, deterioration of clear water, and boggy smells; but not, as has been supposed, in giving rise to malaria, plague, and other maladies.

16. The Infusoria appear to be (as far as is yet known) sleepless.

17. The Infusoria partly decompose (zerfliessen) by egg laying, and through that change passively, and manifold their form.

18. The Infusoria form invisible intestinal worms in many animals and in man, even if the Spermatozoa are excluded from amongst them.

19. The invisible Infusoria have also *lice* and *intestinal worms* themselves.

20. The Infusoria possess a comparatively long life.

21. As the pollen of the Pine falls yearly from the clouds, in the form of *sulphur-rain*, so do the much smaller

animalcules appear (from being passively elevated with the watery vapour) floating in a live state in the atmosphere, and sometimes, perhaps, mixed with the dust.

22. In general, the Infusoria maintain themselves pretty uniformly against all external influence, as do larger organized bodies. It is true that they sometimes consume strong poisons without *immediate injury*, but not without an after effect.

23. The weight of the invisible Infusoria, light as it is, is yet calculable, and the most gentle current of air or draught can play with their bodies as with the vapour of water.

24. The evident and great quickness of the motion of Infusoria, is reducible as follows: Hydatina senta, 1-12th of an inch in four seconds; Monas punctum, 1-12th in forty-eight seconds; Navicula gracilis, 1-12th in six minutes twenty-four seconds.

25. Linneus said, *omnis calx e vermibus:*—either to maintain or deny *omnis silex omne ferrume vermibus*, would be, at the present moment, unjust.

26. The direct observations as yet known upon the theory of *generatio primitiva* are wanting in necessary strictness. Those observers, who profess to have seen the sudden origin of the minutest Infusoria from elementary substances, have quite overlooked the compound structure of these organic bodies.

27.

28. The power of infusorial organization is instinctively shown by the strong chewing apparatus, with teeth, which they possess, and their evincement, likewise, of a complete mental activity.

29. The study of the Infusoria has led to a more distinct and conclusive notion of animal organization generally, and the limits which circumscribe the animal form; from which all plants and minerals, that want the animal organic system, are strongly and distinctly separated.

30. Finally,—it results from these inquiries, that experience shows an unfathomableness of organic creations, when attention is directed to the smallest space, as it does of stars, when reverting to the most immense.

Section I.—*Localities and Appearance of Infusoria in Masses.*

In investigating most branches of practical science, especially those relating to Natural History, the subjects to which our observations are to be directed are generally difficult of attainment, and the inquiry cannot be prosecuted without considerable inconvenience. This, however, is not the case with respect to the *Infusorial Animalcules.* We can examine them in our chamber, at any leisure moment we like, and at any time or season; and we can procure them, at least the ordinary kinds, such as the Paramecium, Kolpoda, &c., with the utmost facility,—for they abound in most waters wherein the stalks of flowers have been a few days steeped—whilst many of the more beautiful kinds, such as the Volvocina, Astasiæa, Hydatinæa, &c., are to be found in pools of clear standing water.

Many remarkable species, and some of the most elegant

I have ever examined, have been taken in meadow-trenches, in the slowly running water, after a summer shower, and especially about the period that the first crop of hay was mown. Among healthy water plants, such as the Chara, Cerotophyllum, Confervæ, Lemna, &c., the various kinds of Vorticellina and Rotatorial animalcules may be sought for with success. The stems of aquatic plants, particularly those of the description just mentioned, have often the appearance, to the naked eye, of being encased with mouldiness or *mucor*, which, on being examined under the microscope, proves to be an extensive colony of arborescent animalcules. Whenever this appearance is of a bluish-milky hue, the species will mostly be those of the Vorticella or Epistylis. (See the *Engravings.*) If you observe little dark bristle-like bodies standing out among the stems, you may expect them to be the Melicerta; and the little yellow gelatinous balls upon the Ceratophillum are, probably, the Megalatrocha. In clear shallow pools, the Volvox globator (*fig.* 55) may be met with in vast numbers in the spring of the year; and, when these are found amongst Lemna, by examining them under a deep magnifying power, you may often discover, within their hollow spheres, the Notomata parasita, like so many white specks. The dust-like stratum we frequently notice on the surface of stagnant ponds, is often composed almost entirely of species of the most beautiful colours, such as the Euglena, Chlorogonium, Pandorina, Gonium, and Bursaria. The thin shining film, which sometimes covers plants in pools of water, assuming the varied hues of red, brown, yellow, green, and blue, is made up also of infusorial animalcules. For example—those objects, which under water appear to

be coated with a thick green matter, abound with the different species of the Euastra and Closterium, the Arthrodesmus quadricaudatus and pectinatus, the Stentor polymorphus, and Vorticella chlorostigma; and those objects which have a bright orange-coloured coating, derive it from the presence of the Stentor aureus.

The abode of animalcules is not, however, confined to the clear fresh water of lakes, rivers, pools, springs, and trenches, but extends even to the briny ocean, to strong acids, tannin, and the fluids contained in the animal and vegetable creation. In moist earth, the species of Bacillaria and other shelled animalcules may also be found; and even the very air we breathe may teem with them and their germs, whilst the gentlest breeze will be sufficient to waft them in myriads over the distant waters, and to transport these living atoms throughout the face of Nature. So that, in short, whether we descend into the deepest mines, where darkness ever reigns, or climb the loftiest mountains, whose summits glow with almost perpetual sunshine, there shall we find them located alike.

Although the colouring of water is sometimes derived from the oxides of iron and other mineral or earthy substances over which it flows, or from the Oscillatoria and other minute algæ which it contains, an intensity of colouring will also be given it by the presence of infusorial animalcules. Thus the Astasia imparts a blood-red colour, as also the Euglena ruber; the Gallionella, Navicula, and Gomphonema, impart an ochreous hue. Blue proceeds from the Stentor ceruleus. Masses of water assume an intense green from Monas bicolor, Uvella bodo, Glenomorum tingens, Phacelomonas pulvisculus,

Cryptomonas glauca, Cryptoglena conica, Pandorina morum, Gonium pectorale, Chlamidomonas pulv., Volvox glob., Astasia and Euglena sang., when young; Euglena viridis, Chlorogonium enchylis, and Ophrydium versatile: yellow from the Astasia flavicans; a milky tint from the Polytoma uvella, and Ophryoglena atra, when they are numerous. A bright orange coating is given by Stentor aureus.

The rapid and mysterious transition of colour which is observable in lakes, and which has often created an alarm in the timid minds of the superstitious inhabitants on their borders, the microscope has shewn to arise from certain changes in the condition of Infusoria. Thus, a lake of clear transparent water will assume a green colour in the course of a day; nay, more, it will become coloured and turbid in the middle of the day, when the sun brings these creatures to the surface, and rapidly develops them, or causes their dead bodies to ascend, whilst in the morning and evening it will again be clear.

The phosphorescence of the sea appears to be occasioned, in many instances, by the presence of animalcules, which, although individually imperceptible, often render luminous many miles of water by the immensity of their numbers.

In the same manner, large arborescent figures, resembling Fuci and Algæ, are formed by the Micromega; and masses of great extent by the Epistylis and Schizonema.

The Bacillaria, or their shell-like coverings (Loricæ) are often spread over many miles of the earth's surface, descending also to a considerable thickness, the remains of which, when they become indurated and mixed with

argillaceous and other earths, contract the forms of siliceous slate, porphoretic rocks, &c., present us with geological facts recorded by the Divine truth, the investigation of which, by the aid of the microscope, unlike the records of human wisdom, biassed by prejudice or alloyed by error, leaves not the shadow of a doubt upon our mind of their prior existence in another condition.

We should not omit to mention a very common mistake with respect to seeking after Infusoria. Some persons imagine that if they procure a portion of fetid ditch water, or take a few flowers and immerse them in a flower glass full of water, they will be furnished in a few days with all the varieties they may desire; the fact, however, is very different from this. It is true, that in such cases, Infusoria will be found, but they will be only of the most ordinary kinds. Those of high interest, either as regards their structure, form, or colour, like all the other masterworks of Nature and of Nature's God, are not so easily attained. Some degree of skill must be exercised for the purpose. But as we shall fully explain this matter in the section on the method of procuring and selecting Infusoria, we need not proceed further with the subject here.

Section II.—*General External Forms, Coverings, Organs, and Members of Infusoria.*

Before entering on the classification of infusorial animalcules, as determined by their *internal* structure, it will be well to make a few remarks upon their general appearance and *external* characters, as exhibited by the microscope. The forms and members of large animals may be said, in one respect, to differ but little from each other; the comparative anatomist being enabled to trace, by easy gradations, one common type throughout the whole, the varieties being occasioned by a greater development of certain parts, and the suppression of others. Such, however, is not the case with Infusoria. The general forms of Infusoria will be best conceived by a reference to the drawings, inasmuch as words would be found insufficient to convey an idea of the vast varieties which they assume. Some are egg-shaped; others resemble spheres; others, again, different kinds of fruit, eels, serpents, and many classes of the invertebrated animals, funnels, tops, cylinders, pitchers, wheels, flasks, &c. &c.

The covering, or outer tunic, of Infusoria, is of *two* kinds; the *one* soft and apparently membraneous, yielding to the slightest pressure, and accommodating itself to the state of repletion or otherwise of the animalcule, and thus resembling the tunic of the naked molusca and annelida, as slugs, leeches, &c.; the *other*, stiff, rigid, and hard, having the appearance of a shell, though, from its flexibility and transparent nature, it is more like horn. The creature identified with the former of these is termed the naked,

shell-less, or *illoricated* Infusoria, whilst the latter denotes the *loricated.* I shall, therefore, adopt the terms *loricated* and *illoricated* in this work, because they appear to be the least objectionable; for, although, in etymological strictness, *lorica* simply means a shell, yet, as we commonly attach the idea of a certain composition to the word shell, it may be as well to avoid the use of it, for the following reasons:—

The *Lorica* differs greatly as to its composition in different species. In some cases it is composed entirely of silica; in others, of lime, with a portion of the oxide of iron. In some, it is combustible; in others, not so. There is a difference also as to the proportion of envelopement of the creature within the lorica. Some Infusoria are entirely encased, as in a box or pitcher; whilst others are only so in part, having merely a shield or carapace over them. In the latter, the covering resembles that of the Chilonia or turtle tribe.

As, in very minute genera, it is often difficult to ascertain, by a mere inspection, whether they are enclosed within a lorica or not, it will not be deemed uninteresting to point out the manner in which this may be determined. Having obtained some specimens of the Infusoria, we will suppose of the family Cryptomonas (*figs.* 21 to 33), place a drop of water containing them in an aquatic live-box, compressor, or crush-box, mixing a little colouring matter with the water, according to the directions given in the section "*On feeding Animalcules with coloured Materials,*" when, if *loricated,* a clear transparent ring will be observed, encircling the animalcules, and keeping them separate from the fluid in which they are immersed:—

should this test, however, be deemed unsatisfactory, press down the cover of the aquatic live-box, so as to crush the specimens, when the coloured fluid will enter and surround their bodies, and by a proper management of the illumination of your microscope, the broken edges of the lorica will be visible, as seen in *fig.* 33, which is a representation of the Trachelomonas volvocina similarly circumstanced.

Until recently, many of the genera of the smaller kinds of animalcules were supposed to be devoid of any *external* organs whatever; but the feeding on coloured substances, and introduction of achromatic glasses, has proved the incorrectness of this conclusion, even as respects the Monads. The simplest external member, observable in the Infusoria, is a single, delicate, hair-like filament, situate near the oral orifice or mouth, and which has, consequently, been designated the *proboscis*. When this member is of an uniform appearance, it is said to be *filaform*, or thread-like; but, when it tapers toward the extremity, like an eye-lash, or cilium, it is denoted *flagelliform*. This organ is used by the animalcule both for locomotive and purpeying purposes. When the creature is in rapid motion through the water, this instrument acts as an oar or paddle, in facilitating a progressive movement, whilst, at the same time, a current is created in the direction of its mouth, for the procuration of food. This member is not easily seen, inasmuch as considerable skill in the use of the microscope is required to shew it, nor will even that, in all cases, succeed. The employment of finely-divided indigo or carmine affords the surest proof of its existence. When, by this means, its action has been detected, allow the water to evaporate, and you may notice

a streak or mark, as it dries, left upon the glass, thus giving conclusive evidence of the presence of this organ. Sometimes the mouth is furnished with two of these probosces, or cilia, nearly of equal length with the body, as in the genera Chlorogonium. Other Infusoria have their oral orifices completely encircled with cilia, in which case they are usually shorter than when only one or two are perceptible, rarely exceeding one-fourth of the length of the body. Others, again, have their bodies wholly covered with cilia, which are often arranged in longitudinal rows, as with the Uroleptus. (See *Drawing*, &c.)

When these cilia are disposed in clusters, as with some of the larger polygastric animalcules, their structure may be more correctly ascertained. In the family Oxytrichina (see *Engraving*), the different modifications of these filaform organs constitute excellent characteristics of the genera; as, however, they are not limited to that particular family, I shall make a few general observations respecting them.

Cilia may be described as hairs seated upon a bulb. They perform a rapid vibratory motion, the point of each describing a comparatively large circle, whilst the base merely turns round upon its articulating surface, or part of the bulb to which it is affixed. Dr. Ehrenberg is of opinion that there are two kinds of cilia, viz. *Cilia continua*, in which the bulb is a continuation, or merely enlarged termination of the cilium; and *Cilia articulata*, in which there is a joint or articulation of the cilium to the bulb. Examples of the former may be observed in the Stylonchia mytillus; and of the latter in the Paramecium aureli, (*fig.* 330.)

It may be remarked here, that naturalists have been greatly divided in opinion with respect to the functions performed by the cilia, more especially those belonging to the Rotatoria. It has been contended by some, that these organs form the chief instrument for respiration; nor is it at all improbable that such is the case, as we find that similar ones are placed round the gills or beard of the oyster, muscle, &c., to produce currents in the water, and bring a fresh supply to the creatures. The disposition of the bundles or clusters of cilia in the Rotatoria, and their appearance when in motion, may be considered as one of the most interesting and curious spectacles in the animal creation. Their strong resemblance to toothed-wheels, and their continual revolution, have been most fertile subjects for the exercise of the imagination; indeed, there are few, if any other, which can excite more astonishment in the beholder. Let the reader turn to the various plates representing the Rotatoria, and mark the great variety of design, and exquisite beauty of execution, there displayed in the forms and dispositions of these wheel-like organs, and his mind can hardly be restrained from reverting, in the profoundest admiration, to that Divine Intelligence by which such wonders could alone have been called into existence.

Setæ, or *bristles*, are a kind of rigid hairs or cilia, used as organs for the support of the body, and for climbing, but without having the power of vibrating like real cilia. These organs are sometimes devoid of the thickened base or articulation, as with the genus Actinophrys (*fig.* 266); whilst others possess a true articulation, as exemplified in the posterior three of the Stylonchia mytillus. Some are

subulate; others have a knob at the extremity, and hence termed *capitate.*

Styles are thick straight setæ, usually seated on the under side of the body, posteriorly, and resembling the tail feathers of birds. These never vibrate; neither have they a bulbous base, nor are their extremities bent or hooked. They are used for the support of the body, and for climbing.

Uncini are curved hook-like processes, like thick short hairs. They emanate from the under surface of the body, and resemble the feet of larger animals. These organs do not vibrate, have neither bulb nor articulation, but sometimes possess considerable latitude of motion.

Variable processes are another description of external members, which perform the function of locomotion in a very complete manner. In the family Amoebaea, the animalcule appears to have the power of protruding, at pleasure, any portion of its body, to form these processes; a qualification which has not inaptly obtained for it the designation of *protean.* In the loricated family Arcellina, the variable processes are definite, the protrusion being restricted to those parts of the body which are situated near the opening in the shell, designed for that purpose. These processes, like the protean ones, are soft or membraneous, and resemble, though on a small scale, those of the Molusca, of which the horns of the common snail are a familiar example. The Infusoria, however, have a greater command than the snails, &c. have over these processes, and a more extended action, in proportion to their size.

In the Infusoria of higher organization, such as the Rotatoria, there are definite processes, of a *toe* or *claw-like*

description, which are mainly used as organs for prehension. These are generally at the extremity of a certain prolongation of the body, which may be designated a foot-like member. To the inexperienced observer, this process has generally been supposed to be the tail; but, not being placed dorsally, with respect to the discharging orifice, it must be considered as occupying the position of the foot. In these creatures, there is a large development also of those parts of the body to which the rotatory organs are attached; and, in the case where two only of these organs are seen, a projection may be noticed on each side of the anterior portion of the animalcule, such as to have obtained for them the appellation of *ears*. For example, see *fig.* 416.

Section III.—*Of the Eyes, or Visual Organs of Infusoria.*

Our knowledge of the existence of these organs is wholly attributable to the invention of the achromatic microscope. In F. O. Muller's work, which contains drawings of the larger number of the animalcules, lately figured by Dr. Ehrenberg, and several of them made with much exactness, though on a very small scale, there is not one of the Polygastrica given as possessing the visual organ, and but one species of the Rotatoria, in which he considered the existence of it as established. By referring to our engravings, however, it will be seen that nearly all the Rotatoria have eyes, and that many of the genera of the Polygastrica are also furnished with them. If no other proof than this could be obtained, therefore, of the

existence of a nervous system in these animated atoms, this might still be taken as a sufficient evidence of the fact.

Commencing, then, with the smallest, and apparently the simplest, as to organization, of the Infusoria, in which the eye is perceived, the first genera is that of the Microglena, in which instance, as in the greater number of others, the colour or pigment of it is *red*. When we reflect that in a living creature, often less than the one-thousandth part of an inch in diameter, so beautiful an organ as this exists, the inference is almost certain that there must be systems also for the performance of various other functions, but which, by their very nature, we are necessarily precluded from discerning.

By taking a glance at the tabular distribution of the genera of each family in this work—a part which is of the utmost value to the zoologist, and on which I have bestowed great pains—the reader will notice, at once, that numbers of the genera of the Polygastrica are furnished with one eye; and, in some cases, which however are more rare, with two.

In the Rotatoria, the number and position of these organs may be regarded as excellent characteristics of the genera. In the greater proportion of these, as before stated, the animalcules have two, and, in some instances, three eyes; whilst, in one genus, the Theorus, as many as seven or eight have been distinctly recognized on each side of the head. When the eyes are situated in front of the œsophagal bulb, to which the teeth are attached, they are termed *frontal eyes;* and when behind this bulb, *cervical eyes.* They are sometimes disposed in a line,

side by side, as in the Triophthalmus; and at others, arranged triangularly, as in the Eosphora. In the Cycloglena, they form a circle; and, in the Theorus, a cluster on each side.

Section IV.—*Distinction between the Infusoria and other Minute Animals, &c.*

In our present state of knowledge, with respect to organic bodies, there are many difficulties in the way of determining on such boundaries as may reduce them to well defined groups. Even the line of demarcation between animals and plants, which, at the first blush, might be supposed to be so very broad and distinct, upon a more minute consideration, is not easily settled. The plan of this work will comprehend a description of those creatures which are generally to be found in animal or vegetable infusions, and such as agree with them in their general structure and habits.

In *Die Infusionsthierschen*, the author has occasionally introduced animals which have been classed under other divisions of the animal kingdom. As examples, we may take the family Dinobryonia, the members of which are classed as zoophites by other naturalists. Again, in the genus Bodo, some of the species are proper Entozoa, and, therefore, ought to be excluded. Having, however, taken that work as the basis of my arrangement, all the species described therein will be found here.

With regard to the spermatozoa of animals, our knowledge of them is but scanty and confused, arising principally

from their extreme minuteness, which, even with the assistance of our most perfect microscopes, places them at the very limit of our vision. The great importance of this subject, especially to the medical professor, has obtained for it, from several distinguished naturalists, long and laborious researches; but, on the whole, the results have been so contradictory, as by no means to justify the introduction of them into this manual. It will be sufficient, therefore, to say, that since the time of their discovery (1676), up to the present period, all that we know of the *true* Spermatozoa of animals, is, that they are not distinguishable from the Cercaria found in the liver of snails, the animal organization of which has been made out by Bauer, Wagner, and Ehrenberg.

The recent discoveries of Dr. Unger on the spermatozoa of plants is a subject of such deep interest, and so little known in this country, that I have introduced a description of them under the genus Spirillum; while original drawings of them will be found in *Plate* XII.

It has been said that the line of demarcation between many species of animals and plants—the transition from the one kingdom to the other—is not easily defined. Indeed, so close is the connection between them, that some members of the families Closterina, Vibrionia, and Bacillaria, which are considered by Ehrenberg to be animals, are, by many eminent botanists, set down as belonging to the vegetable kingdom, and classed with the minute aquatic algæ of the genera Oscillatoria, Spyrogyra, &c. The true species of the two genera just named, it must be admitted, are not of animal structure; and Dr. Ehrenberg has given us the following reasons why they are not included with

the Infusoria :—1. They have no oral aperture. 2. They never propagate by direct self-division, but by the mere dissolution of the gemmæ. 3. They increase in size only by the growth of the gemmæ. 4. They have both the external and internal rigidity of vegetable organization. 5. The impregnation of the Spyrogyra resembles that of some of the species of Fungi. 6. They develope acicular crystals within themselves, like some well-known plants. 7. Their motion is not perceptibly voluntary. For further particulars, see remarks on the Closterium, Part II.

Spontaneous Generation. — Many of my readers may expect to find some notice of this subject, as the Infusoria are considered to have a *generatio primitiva,* or, in other words, are produced by some fortuitous combination of circumstances from inorganic matter. That such a statement is untenable, most persons will be inclined to admit, who have perused the description contained in the Second Part of this work. All the observations that can be depended upon tend to show that infusions of vegetable or animal matters, whether natural or artificial, only offer food for the nourishment of these living atoms, whose germs are almost everywhere present, but are only developed in situations congenial to their natures. It is now well ascertained that the old notions of certain vegetable infusions producing a definite species of Infusoria is an error; that, in general, we have, in all artificial infusions, only common species, and that these invariably making their appearance, we may fairly presume their eggs are more generally dispersed and more readily developed. On the other hand, the Rotatoria, and more beautiful

species of Polygastrica, are confined to localities more open to the fresh air. Ehrenberg, for many years, has experimented with simple spring water, with distilled water, and rain water, and these both boiled and cold, as also with and without vegetable matter; that in open vessels, after a longer or shorter time, depending upon temperature and other circumstances, he invariably found the Infusoria; while, in closed vessels, they were rarely to be met with; so that, I think, we may consider *generatio æquivoca*, even in Infusoria, as an unphilosophical hypothesis; and that the same fixed laws of Creative Wisdom, which regulates and governs the smallest satellite and the largest starry world through boundless space, has established the same law for the developement of a living atom, as is manifested to us in the largest animal that inhabits this planet.

SECTION V.—*On the Method of Capturing, Selecting, and Placing Infusoria for Examination under the Microscope.*

Having provided yourself with a number of clean glass wide-mouthed phials—those containing about four ounces a-piece will be found most suitable—let them be fitted with proper corks, and not with glass stoppers. If it be required to have all the tackle neatly arranged, they may be put into a small case, expressly constructed for the purpose, and each bottle separately marked. In place of phials, however, cylindrical glass vessels, from three to five inches long, may be substituted with advantage, as they will lay better in the case, which need not exceed the dimensions of a common sandwich-box. A good walking-stick, with a

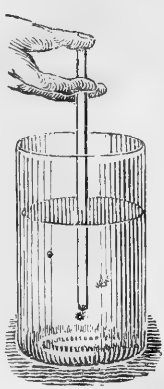
hook at the end of it, and a piece of twine, should always form part of the equipment. As the margin of small ponds is sometimes difficult of near approach, I have contrived a spring-hook, which is attached to a moveable ferule, and made to fasten to the end of the walking-stick. This lays hold of the neck of the phial, and enables you to charge it from the surface of the water, in the immediate vicinity of the stalks of water-plants, a situation generally abounding with Infusoria. Take with you, also, a pocket magnifier, of shallow power. This may be mounted in various ways; but the one I prefer is the triple, having the lenses arranged in the same plane; the convenience of which is, that you will have three different powers always ready for use, without the necessity of moving them; and that, the mounting being flat, it will be very suitable for the waistcoat pocket. Sling this, with a piece of ribbon, about the neck, and there will be no danger of losing it. The magnifying powers usually selected are those from five to fifty diameters; the first, or largest, serving to distinguish the masses; the intermediate, to show the general movements, so as to determine pretty nearly whether the water you have collected is worth retaining or not; and the smallest, or most powerful, for examining the contents with more minuteness. This latter power will not so frequently be called into use abroad as at home; because, with a little practice, the middle and shallow powers will be found to answer every purpose.

Having now mentioned all the needful apparatus, proceed to the nearest ponds of water in the neighbourhood, and should there be healthy Lemnæ on their surface, or Confervæ, or other aquatic plants, you will be almost

certain to meet with animalcules. If there be any drains, however, communicating with them, the chances are that they contain only the common species, which will, by a little practice, be readily distinguished by their motion, general appearance, and colour. The indications of the presence of Infusoria are specks moving about in the water, or an apparent mouldiness around the stalks of the Lemnæ, &c. Should these appearances not be discerned under the middle power of your magnifier, throw away the water, and repair to some more favoured pool. Be careful to take only a small portion of the vegetable matter in your vessel, as its decay, and consequent evolution of gas, may soon kill all your animalcules. This must be constantly borne in mind. Clear pools of water, in the spring of the year, are the favourite places of resort for the Volvox globator; clear water, slowly running in clay or chalky soils, for the Bacillaria and Arcellina. House gutters, and tubes placed to receive the rain water, often contain a rich supply. In the winter, you may search for them in water among dead leaves, reeds, &c., which may be taken out, and their contents shaken off into some clear water; while the species which attach themselves firmly to these objects may be examined without their being removed from them. Dr. Ehrenberg states that he has met with good success in the winter under bridges, around the piers and outworks, and even in frozen ditches beneath the ice. When you have filled your vessels, cork them carefully, so as to exclude the air, for the shaking of the carriage, when a quantity of air is left in the vessels, will often destroy them before you arrive at your place of destination. In this respect, my mode of proceeding differs from that of

Dr. Ehrenberg, who always leaves a small proportion of air in the vessel; judging, therefore, from my own experience, I should conclude that he is more careful than myself as to their conveyance. The only inconvenience I have experienced from keeping the vessels entirely filled with water, during the short time of transporting them home, has arisen from those creatures which appear to live on the surface, attaching themselves to the cork, and remaining so when required to be taken out. Remove the corks as soon as you get home, and place the vessels upright; for which a mahogany stand, furnished with a number of holes adapted for the vessels, will be very convenient. A gauze covering, fitted to the frame, will keep out the dust and blacks, without obstructing the free ingress of air.

We now proceed to the mode of investigating these minute creatures under the microscope. If the kind to be examined are those which swim freely, and are visible to the naked eye, as the Volvox, Bursaria, and other large Polygastrica, and also the free Rotatoria, take a small open glass tube, such as is described in the *Microscopic Cabinet*, p. 236, and select the specimens with it in the manner there recommended. The figure of the tube I here insert from that work. The diameters of these tubes may vary from one-eighth to one-twelfth of an inch, and their length from four to six inches. It may be useful occasionally to draw out and slightly bend the extremities which are to be immersed in the water.



When the creatures are more minute than

those above mentioned, pour a little water from the vessel containing them into a watch glass, and place it upon a piece of cardboard, rendered half *black* and half *white.* The white ground will make the dark specimens apparent, and *vice versâ;* thus, the required specimens may be taken out singly with one of the tubes, and placed in the aquatic live-box for observation. The observer will derive much assistance in this operation from the use of the pocket-magnifier before mentioned, or from a watchmaker's eye-glass.

When the Infusoria are extremely minute, they usually congregate at the edge of the water over the white portion of the cardboard, and may be removed from thence with the point of a quill, or of a small wedge-shaped pencil. If a quantity of the Chara, or other aquatic plants, be put into a glass jar with the Infusoria, in the course of a few days, more or less depending upon the temperature of the season, the surface will be covered with a thin pellicle, formed by the decomposition and extrication of gas, causing the small detached pieces of vegetable matter to float upon the water, and with them the Infusoria. Let a small portion of this film be taken from the surface, by means of the feeding pin, described in the *Microscopic Cabinet,* p. 235, and examined under the microscope, and you will hardly fail of being highly gratified. Among the most interesting genera collected from the surface of these infusions, in the manner just stated, are those belonging to the families Arcellina and Astasiæa. After the film has remained some days upon the water, many of the above-mentioned genera disappear, and are succeeded by those of the family Vibrionia, especially the Bacterium. These,

however, may be easily overlooked; for they merely resemble, even under a power of 250 diameters, scintillations, or the vibrations of cilia, among the vegetable matter. But, when carefully examined under a deeper power, they will appear like so many small short rods, each rod, or chain, having a distinct movement of its own.

Section VI.—*Effects of Temperature on Infusoria.*

As vitality in these creatures is not destroyed by the ordinary cold of winter, most of the common Polygastrica may be found at that season in ponds under the ice. The Vorticella microstoma will live after being exposed to 8° of Fah., and the ice gradually thawed; although the number in this case may not exceed one in a hundred. Below this temperature they will not survive. The same may be said of the Monas termo and spirillum, the Paramecium aurelium, Cyclidium glaucoma, Glaucoma scintillans, and Kolpoda cucullus. When Infusoria are destroyed by the cold, no rupture or injury will be apparent on their bodies, excepting with the Chilodon cucullus, and some few others, which, under these circumstances, will often become dissipated. The Stentor polymorphus and mulleri will not live many hours in a temperature of 9° Fah.; and arborescent Vorticella, when subjected to that degree of cold, fall from the stalks and die.

The Rotatorial animalcules cannot endure so low a temperature as those above named.

When a small quantity of water, having animalcules

in it, becomes frozen, and is placed under a microscope, in a cold situation, Dr. Ehrenberg states that if the ice be clear, each animalcule or group will evidently be surrounded by an exceedingly small portion of water, which that naturalist supposes to be occasioned by the superior temperature or animal heat of the creatures preventing congelation; and he is of opinion, that in all cases where this portion of the water freezes, the animalcule necessarily dies.

If the water containing polygastric Infusoria be gradually raised to a temperature of even 125° of Fah. these creatures will live; and Dr. E. observes, that some of the Chlamidomonas pulvisculus existed, on one occasion, in water at 200° of Fah. If the increase of temperature be sudden, the animalcules die at 140°, notwithstanding it be kept up for only half a minute.

Section VII.—*Effects of Air, Chemical Mixtures, and Poisons, on Infusoria.*

That animalcules, like every other part of the animal creation, continually require fresh supplies of atmospheric air for their support, may be deduced from a variety of experiments. If a thin pellicle of oil be spread over the surface of the water in which they are retained, they very soon die from exhaustion; and indeed, it must have often happened to those who are in the habit of collecting Infusoria, that when the cork has been left, by accident, too long in a phial full of water, they have experienced this mishap. This is especially the case with

respect to the large Rotatoria: whenever experiments have been made with these creatures under an exhausted receiver, the result has invariably been that vitality ceases soon after the air has been expelled. Dr. E. states, that they exist much longer in an atmosphere of nitrogen than in carbonic acid or hydrogen. The vapour of sulphur soon puts a period to their existence.

Poisons, which only mix *mechanically* with water, do not appear to affect them materially, but those which are soluble, or combine *chemically* with it, speedily destroy their lives. Many of the Infusoria can accommodate themselves to different fluids, provided that the transition be not too sudden. Thus, similar species may be found in rivers, at their source, where the water is perfectly fresh, and at their very mouths or junction with the salt water of the ocean. Hydatinea have been fed upon powdered rhubarb without being sensibly affected by it; nor does calomel or corrosive sublimate kill them; at least they live some time after these have been mixed with the water. Strychnia causes instant death.

SECTION VIII.—*Effects of Electricity, Galvanism, and Magnetism, on Infusoria.*

All the experiments on record, which have been made upon animalcules with these powerful agents, appear to me to have been conducted without a due regard having been paid to their diminutive size; and hence, as might be expected, the results have proved fatal to their existence. We have, therefore, yet to learn what effects

might be produced under proper modifications. To render this proposition more intelligible, suppose, for instance, that we wished to ascertain the temperature in which fish would live, we should not expect to arrive at the desired information by plunging them suddenly into boiling water. Dr. E. has remarked that a shock from a leaden jar, charged with twenty sparks from an Electrophorus, having a resinous plate seven and a half inches square, and a collector five and a half inches, suddenly killed the Volvox globator, Stentor niger and aureus, Ampileptus moniliger, Chalamidomonas and Euglena viridis. The bodies of the Ophryoglena atra and Stentor polymorphus were entirely dissipated by it, and also those of the Epistylis flavicans, after having been first thrown from their stalks. It generally required two such shocks to kill the Paramecium aurelia. When the electrical current passes near, and not through them, their movements appear to be unsteady, in the same manner as when the mental faculties in the larger animals are disturbed. Electricity, slowly produced, has a more powerful effect than when it is accompanied with rapid sparks. If water, containing animalcules, be placed between the poles of a galvanic battery, so as to be decomposed, of course, the creatures die; and a like termination will be occasioned by magnetic currents.

For a description of an apparatus for electrifying Infusoria, see *Tracts*.

Section IX.—*On the Resuscitation of Infusoria.*

In almost all ages of the world there has been evinced a restless desire within us to pry into the nature or principle of *life*, and the precise conditions on which it is retained; and, notwithstanding that our bodies, its present *abiding place*, are confessedly frail and perishable, the unravelling of an invisible and immaterial agent has been sought for by a reference to them. Hence, each succeeding generation has occupied itself in proving the fallacy of preceding theories on this mysterious subject, and in forming new ones of their own. Even in modern times we have been told that dead matter, under certain circumstances, becomes spontaneously alive, such as horse-hair under water, &c. Too true it is, however, that, let our researches be what they may, unless our views are directed upwards to a higher principle than anything that we can argue upon, in what we see around us, our labours must end in nought but "vanity and vexation of spirit."

What, perhaps, has tended to awaken our inquisitiveness on this subject, more than anything else, has been that death-like condition of sleep, or suspended animation, in which human beings and other animals have been known to remain for a great length of time, during which the body is motionless, and apparently unsustained by any nourishment whatever. In 1701, Leeüwenhoek observed these appearances in the Rotatorial Infusoria; and to such an extent did his observations proceed, that

he declares they were capable of being removed from their native element, *dried up*, and preserved in this condition for months, and even years, and then resuscitated on being again moistened with water. That Rotatorial Infusoria will revive, after remaining a day or two, apparently in a dry state, I have particularly mentioned in the *Natural History of Animalcules.* The distinguished author of *Die Infusionsthierchen,* after many illustrations and comparisons made with reference to this subject, affirms, that wherever these creatures are completely desiccated, and their natural heat is gone, life can never again be restored. In this respect, they exactly correspond with animals of a larger kind; like them, for a time, they may continue in a lethargic and motionless condition, but, as it is well known, there will be going on, within them, a consumption, or wasting away of the body, equivalent to so much outward nourishment as would be needed for the sustentation of life.

Section X.—*On the Supposed Method of Manufacturing Infusoria.*

Within the last few years an idea has been prevalent, and many persons have occupied themselves in endeavouring to realize so extraordinary a discovery, that animal life may be produced by means of galvanism. The creatures said to have been thus brought into existence, that have come under my observation, were neither the most minute, nor the most simple, in organization; and evidently belonged to the class Acari. That many

scientific men should be more than sceptical upon this point, cannot be wondered at; and were it not that the notion originated with, and the experiments have been conducted by, one who holds a most honourable position amongst us, it would not have been entertained for a moment. That some mistake exists with respect to communicating vitality to matter, by this means, there cannot be a doubt.

It is not surprising that Linneus, with the imperfect microscopes of his day, should mistake Infusorial animalcules for minute drops of oil in the water; but that Dutrochet, so late as 1833, should publish to the world that all the globular and elliptical Infusoria were vesicles set in motion by streams of electricity, and therefore could be artificially produced, is but another exemplification of the fact, that men of the most distinguished talents in one department of science may form very erroneous notions on others, especially where long continued observations, and very accurate perceptions, are indispensable for arriving at right conclusions respecting them.

In 1834, Cagniard Latour made a public declaration, that he had manufactured animalcules by the aid of carburetted hydrogen. This assertion led to an examination, subsequently, of the creatures, by M. Audouin, who ascertained them to be a species of the Entomostracea, and who did not hesitate to pronounce the method, by which they were said to have been produced, to be fallacious.

The most ingenious experiment on the imaginary production of Infusoria is that of Professor Bonsdorffs, which he communicated to the German Naturalists' Asso-

ciation in 1834. The following is Ehrenberg's account of it:—"If a solution of the chloride of aluminum be dropped into a solution of potassa, by the attenuate precipitation and solution of the aluminum in the excess of alkali, an appearance will be given to the drop of aluminated matter, by the chemical changes and reactions which take place, as if the Amoeba diffluens (see description, Part II.) were actuallypresent, both as to its form and evolutions, and it will seem to be alive. Such appearance is considered, by its able discoverer, as bearing the same relationship to the real animalcule as a doll or a figure moved by mechanism does to a living child."

Section XI.—*On the Evolution of Light by Infusoria.*

Several small animals are known to emit light, apparently phosphorescent, as the female glow-worm, and some species of the Miriapoda, which I have frequently noticed in the gravel walks of a garden, on a dark autumnal evening. This emission of light, whether in the above-named animals, or in Infusoria, is evidently the result of a vital process. In the latter class of creatures, it seems like a single spark, of a moment's duration, but capable of being repeated at short intervals. That this light is electrical, analogy would lead us to infer; as experiments made upon larger creatures have proved it to be such with them.

The phosphorescence of the sea is produced by Infusoria, chiefly belonging to the family Cyclidina; and when

we take into consideration the minuteness of these creatures, the largest not exceeding the 1-100th of an inch, whilst some of them are scarcely 1-12th of that size, our ideas of computation are too limited to form any just notion of the number which sometimes illuminate many miles in extent of the ocean's surface.

Section XII.—*On the Relative Number or Abundance of different Infusoria.*

It has been stated that some species of Infusorial animalcules are more commonly met with than others, and occur in greater numbers. In the List of Species, inserted at the end of this part, those marked with a single (*) thus, are common in vegetable infusions, while those with (* *) thus, are more abundant, and those with a greater number of stars attached to their respective names are still more universally found.

The most numerous in animal infusions are those of the Monas crepusculum, Spirillum undula, Vibrio regula, Leucophrys carnium, and Polytoma uvella; in sea water, the Paramecium milium and the Stylonychia.

Section XIII.—*On the Method of Feeding Infusoria with Coloured Substances.*

Select for this purpose such coloured substances as are entirely free from metallic oxides, and not chemically soluble in water. They must, however, be capable of a

very minute mechanical division. The bodies generally used are those of carmine, indigo, and sap-green, the first being preferable. This material should be as pure as possible. Take a piece or cake of it, and rub the corner once or twice on the stage-glass, or what perhaps is better, the lower plate of an aquatic live-box, having first moistened it with a drop of water. The colouring requisite for the purpose is very small—only just sufficient to render it appreciable to the naked eye—for if there be too much, the probability is, that the particles will be too large for the creatures to imbibe. Having thus prepared the coloured food, place a drop of it beside a drop of the water containing the animalcules, but not so that they may come into contact; then put on gently the cover of the live-box, and lower it sufficiently to flatten the two drops of fluid, but not to force them to unite. Now place the live-box under the microscope, and examine the animalcules as closely as you can, and especially so as to ascertain that their stomachs are colourless; then press down the cover until the drops of fluid intermix, which may be done under the microscope, and you will immediately perceive the creatures in great activity, and readily distinguish the cilia, proboscides, and other organs, of those which possess them, and in a few seconds their stomachs will be filled with the coloured substance. Some animalcules, however, take a considerable time to effect this, but it is an exception to the general rule.

Section XIV.—*On the Mode of Drying and Preserving Infusoria.*

Although such exceedingly small creatures as animalcules, when dead, lose many of their characteristic features, especially the soft-bodied ones, yet, for the verification of some parts of their structure, it is absolutely necessary to observe them in a quiescent state; and hence, a method of effectually drying and preserving them must be considered essential. Bacellaria, in this condition, have often been preserved by botanists, in collections of minute Algæ, and with very little management; but other families will require more care. Having selected the creature you wish to preserve, remove it with a fine pointed quill, and put it on a slip of glass, or other convenient receptacle. By this means there will be but a small portion of water surrounding it, which may be extracted by some pointed pieces of ragged blotting paper. When you have withdrawn as much of the water as possible from the specimen, the remaining moisture may be readily evaporated, by placing the glass on the palm of the hand. The Hydatinea may be best preserved when destroyed with strychnia, and then rapidly dried. By what mode soever life may be taken away, it is absolutely expedient that they should be speedily and carefully dried, otherwise their bodies will be decomposed, gases evolved, and the object will fail.

The best way of mounting for the microscope dried Infusoria will be on slips of plate glass, having a polished circular cavity, in which to deposit the creatures.

These may be numbered, or otherwise marked, with a writing diamond, and a large collection of them arranged in a very compact case.

Fossil Infusoria are best preserved in Canada balsam, under thin slips of glass.

Infusoria, when simply dried, may be relaxed again by moisture, and some of them will bear this operation several times—the soft-bodied ones, however, only once. The general colour of Infusoria is retained for a considerable time after they have been dried, but the pigment of the eye is soon lost. It may be well to observe, that when the preserved specimens are intended to illustrate the nutritive system, they should be previously fed with colouring matter; but for observations on their muscular system this is not advisable.

Section XV.—*On Infusoria contained in Flints and Semi-Opals.*

It is hardly possible to take up and examine a dozen flints without discovering species of Infusoria inclosed within them. These may be best seen under the microscope, when very thin sections are made, like those of fossil woods, teeth, coal, &c.: when these are polished and cemented on glass sliders they are permanent objects. Small splinters of flint, broken off, may be used for investigation by the microscope, but such experiments are attended with very considerable danger to the object-glass of your instrument, by its being brought accidentally into contact with their sharp edges, which oftentimes cut

and injure it without your being immediately aware of the fact.

Section XVI.—*On Microscopes for Examining Infusoria.*

A good microscope cannot be fully appreciated until it is brought to the examination of living Infusoria. It is true, that we may make use of the scales of insects and other similar objects as tests—we may see with wonder the different markings on the surface of these dust-like atoms, but our admiration will be carried still higher, by the development of those brilliant colours and delicate tints which are discoverable in many species of the minute Infusoria. The criterion of a good microscope, then, will be, that not only the forms of these little creatures, their curious structures, organization, and digestive apparatus, are exhibited with perfect clearness, but that there is also shewn the deep and brilliant colouring of their visual organs, and the delicate tints of their variable, retractile, and locomotive processes. These living *points*—for the space they individually occupy is hardly conceivable any more than, taking the other extreme, and carrying our views over the vast expanse of the starry heavens, we can scarcely appreciate their magnitudes; and hence our thoughts are alike directed upwards to a Being, whose comprehensiveness knows no limitation or bounds. In this respect, the pursuit of the astronomer and the naturalist may be said to be the same, for both travel very far, but are ultimately lost in that infinity of purpose, to which the human intellect cannot attain. What can be more

wonderful than the contemplation of these atoms, these limits of man's perception, endued with living faculties and instincts, in all respects as perfect as those of any other created being.

The various methods of managing the microscope, and the different apparatus subsidiary to it, have been so fully expatiated upon by the late Dr. Goring, my much esteemed colleague, and myself, in our joint works, *The Microscopic Illustrations, Cabinet, Micrographia, &c.*, that it will only be necessary here to notice, briefly, a few particulars, which more especially relate to the subject before us, and to refer the reader to those works for all further information. As the expense of instruments, in the commencement of our studies, is often an important consideration, a few words on this head may not be considered inappropriate, on this occasion. Dr. Ehrenberg informs us, that he began his observations with a common microscope, and, although by his superior talent and unwearied labour, thus aided, he was enabled to make some important discoveries, yet he delayed, for some years, the publication of them, until he could verify them with better instruments.

At the period when our first publication was announced (1827) an interest in microscopic science had to be created, to which I may add, that the achromatic microscope was then in its infancy, Dr. Goring having only a short time previous (1824) discovered the conditions on which their efficacy depended, namely, *large angular aperture free from aberration.* That publication aroused the attention of scientific men to the subject, but instruments, even such as those then made, were very difficult to procure. To obviate this difficulty, Dr. Goring and

myself determined on presenting the public with detailed methods of constructing and testing achromatic microscopes. I further directed the attention of my workmen to the subject, and gave them, from time to time, such information, as, with their skill and perseverance, might advance them in this branch of art, and I believe, up to the present time, the only successful artists in this country are those who have been in my employ.

In cases where an achromatic microscope cannot be procured, recourse should be had to single lenses or doublets, for the ordinary compound, however well constructed, cannot be depended upon.

With respect to the cost of an effective microscope, with a moderate equipment of apparatus, such for example as the one described in the 6th chap. of the *Microscopic Illustrations,* which is of the best construction I have seen, the price would now be from 20 to 30 guineas. As there are a great many persons who require only a plain, sound instrument, of more moderate cost, I have deemed it expedient to take this also into consideration, and, after much application and repeated experiments, have at length produced one, in every way suitable to the case. Such is my *vertical tripod* achromatic microscope. It may be stated that nine-tenths of the observations recorded in this work may be repeated and tested by this microscope. On comparing the above instruments with that used by Dr. Ehrenberg, there is no doubt that, in point of mechanical construction, they are greatly superior, whilst the optical part is equal to any with which his researches have been made.

In adverting to this portion of my subject, I am

necessarily obliged to speak of my own productions, and even to praise them, however objectionable it may seem, and repugnant to my own feelings; but I have done so, because firmly persuaded that it will be serviceable to many persons, and this, I am sure, will be received as a sufficient apology for intruding myself into this work. In order to draw a fair comparison between different instruments, I have, at great cost, possessed myself of the best object glasses of all the foreign artists of note, and having most patiently and carefully made trial of their efficiency, no doubt rests upon my mind as to the rēlative qualities of each. Of the mechanical part of the continental microscopes I have elsewhere expressed an opinion.

The magnifying powers of a *complete* microscope for perfectly examining *all* kinds of Infusoria should range from 50 to 1000 diameters; and as this cannot be obtained with first-rate glasses, without recourse being had to several sets, such an instrument would be necessarily expensive. The microscope first mentioned has two or three sets of glasses, varying from 35 to 500; and the second, one set, from 80 to 300 diameters; so that, as before stated, all the most interesting observations on Infusoria may be conducted with either of these instruments, whilst additional sets may be obtained as occasion requires.

It is important to notice, that in all cases where the magnifying powers of microscopes are spoken of, the standard of sight used in computing them should be known, otherwise very erroneous ideas will be formed. In all my publications, from 1827 up to the present time,

reference has been had to a *ten inch standard,* and the enumeration of powers has been in *diameters,* or what are sometimes termed *linear;* thus, what I compute at 100 is often spoken of as 10,000, that being the superficial measurement; ample reasons for the adoption of *linear measure,* and for that standard, are given in my works on this subject.

In demonstrating minute portions of the structures of Infusoria, a power of 800 diameters will sometimes be requisite, unless the sight be exceedingly good. I have invariably observed that aged persons require greater assistance, in this respect, than young ones. Nothwithstanding this, it will be impossible to arrive at an accurate knowledge of the creature you may be studying, even with a power of 800, unless it has been previously examined under a lower one, so that the relations of its several parts may be first clearly understood. Whenever the object in view is merely that of instructive amusement, a power of 250 diameters will be amply sufficient; that power can be managed with ease, and does not fatigue the observer. The greater number of Dr. E.'s discoveries were effected under a power of 380. I am not aware whether he has mentioned in any of his works the siderial focal length of his object-glasses, or the standard of sight. The set which Dr. E. speaks most in praise of is similar to one which I possess, and which has a focus of1-7th of an inch. He considers that with " a good achromatic microscope and a lamp, our observations may be carried on at night as well as in the day, which, by some, may be esteemed as an additional recommendation."

Section XVII.—*On Micrometers, and the Method of Measuring Infusoria.*

The late Dr. Goring, in the *Micrographia,* has described the method by which, in various ways, a correct admeasurement may be taken of these minute creatures, as also Mr. Bauer, in a paper in the same publication. I cannot do better than refer the reader to these authorities, for the fullest information attainable on this subject. A few words, however, may be said on the mode of proceeding which I have myself adopted, and which, after much practice, has been productive of very accurate results. It is as follows:—Having set up the microscope and screwed in or adapted the glasses which are intended to be used, take a glass micrometer, and place it on the stage in the same manner as if it were an object to be viewed, then carefully adjust the focus of your instrument, so that the *lines* on the micrometer may appear quite sharp and distinct. Next, take a common ruler, or a slip of card-board with equal divisions of some known measurement drawn upon it, every tenth division being longer than the rest, and fix it 20 inches from the eye, whilst looking through the microscope; then, whilst one eye is directed to the rule or card-board, and the other to the lines of the micrometer, seen in the microscope, ascertain how many on the card are equal to a given number on the micrometer. If the divisions on the latter be 1-100th of an inch, and one of them be equal to ten on the card, it is clear that every division on the card will represent

1-1000th of an inch. Thus, when the micrometer shall be removed, and an animalcule be put into its place, if the creature subtend five divisions on the card, its size in linear measure will be 5-1000th of an inch. Note—The glasses must not be changed during the experiment, nor their distances apart; neither must the distance between the card and the eye be in any way altered.

Section XVIII.—*On Glass Tubes, &c. for taking Infusoria from the Water, and placing them in the Apparatus for examination.*

As these useful little contrivances, which have been before alluded to in this Part, were drawn and described in the *Microscopic Cabinet* more than ten years ago, it will be necessary merely to mention that little or no improvement has been made upon them since that period, excepting perhaps that a *finer* description is found to answer the purpose better than when the larger ones are drawn out at their extremities in the manner there proposed.

Section XIX.—*On the Compressor, or Crush Box.*

The last remark is equally applicable to the Aquatic-live-boxes, which were described in the *Illustrations*, 1828, and subsequently their different modifications. In order to form an idea of a compressor, or crush-box, you must suppose that the cover of the live-box is so adapted

to its box by a screw, or some other convenient means, as that a small body placed under it may receive a certain degree of pressure without its parts being dislocated. In my original live-boxes, this was effected by a screw being attached to the cover; but, in the ordinary way, the cover is made to revolve. In some, a guide-piece has been substituted for the screw, so that the pressure is obtained without the glass-plates sliding one upon the other. The German opticians attach the cover or upper plate to a jointed lever, at the longest end of which a screw is applied, which brings the upper plate connected with the short-arm, in contact with the lower plate. The use of the crush-box is to protrude certain parts of the animalcule for examination by pressing down upon the creature. In this manner, the teeth of the Rotatoria become distinct. Other uses of this apparatus are given when speaking of the minute loricated Polygastrica.

SECTION XX.—*On Viewing Infusoria by Polarised Light.*

Having in the last edition of the *Microscopic Illustrations* given a full description of the Polarizing Microscope, and the apparatus necessary for using any microscope for polarising purposes, a very few remarks on the effects produced by viewing Infusoria under this light will be sufficient here.

The siliceous covering of Infusoria is but slightly affected by polarised light: that the effect is only feeble, is attributable to the extreme tenuity of their shells, for could we but contrive the means of magnifying the effect, I feel

convinced that some very important results would be obtained. The ribs or striæ on the navicula assume a slight tinge of colouring when the polarizer and analyzer are parallel to each other; but when they are crossed, owing to the few rays which are transmitted, I was unable to perceive it. Isthmia are slightly influenced by polarized light. The larger Infusoria I have not examined, nor am I aware that any information is recorded on this subject.

Section XXI.—*On Viewing Infusoria by means of the Black Ground Illumination.*

The muscular fibres of the Rotatoria, and the markings on the lorica of the Bacillaria, &c. are brought out in a most remarkable manner by this mode of illumination. For an account of the method of examining objects in this way, see *Microscopic Illustrations*, p. 138.

Section XXII.—*Classification of Infusoria.*

Among the various arrangements proposed for the distribution of animalcules by different naturalists—and we have not a few, as the minuteness of these creatures and the imperfections of our microscopes, until lately, allowed ample field for the imagination to run wild—two only appear to me to merit particular notice, and these, it is worthy of remark, are the productions of men who have laboured for years in making actual observations on them. The first is by O. F. Müller, whose posthumous work, entitled

Animalcula Infusoria Fluviatilia et Marina, appeared in the year 1786. On this arrangement is founded my *Natural History of Animalcules,* prepared in 1832; between these two periods the additions to this branch of natural history, from actual observation, was not very great; indeed, until the latter work appeared, this subject could not be said to have assumed a definite character, and was unknown to the English reader.

The laborious and long-continued observations of Dr. Ehrenberg, in Germany, have enabled him, after several revisions and amendments, to present us with a classification which, in my opinion, will remain as long our standard, on this subject, as that of Müller's has been. It is curious, however, to observe, that in all the publications, up to the present day (in England at least), professing to give an account of Dr. E.'s classification, they have taken it from his older and I may say abandoned systems.

Dr. Ehrenberg, in his great work entitled *Die Infusionsthierchen,* has not devoted much space in defining the term Infusoria, or in giving a general view of the subject; but he commences almost immediately with the class Polygastrica; hence the Second Part of this work will give the reader some idea of the general arrangement of that splendid work; though the design of the two differing, namely, the latter being a work of reference, this a manual, many alterations, omissions and additions have been made; and hence it will be alike unjust to that distinguished naturalist, as to myself, to consider the one a mere abstract of the other.

Should the reader possess a copy of the *Natural History*

of Animalcules, and will make a general comparison between the system adopted in that work and the present, he cannot fail to observe that, although the principles of the classification of Müller and Ehrenberg are widely different, yet many of the groups of animalcules occupy, as a whole, similar positions, in the two systems. This analogy I was much struck with in the place of the Vibrio of Müller and the Bacillaria of Ehrenberg, while the commencing and concluding genera in each system are similar.

Dr. E. divides the Infusoria into two grand classes; the animals belonging to the first are called *Polygastrica*, and are distinguished from the second class, named *Rotatoria*, by the function of digestion in the former being carried on by numerous globular vesicles, or stomachs, while the creatures belonging to the latter, like most large animals, have only one stomach for digestion.

Polygastrica.—The microscopic observer, having procured a number of animalcules, will not fail to observe within the interior of many a number of circular spots; these are often very large in proportion to the size of the creature, and if the water is clear, they are more transparent than the other parts of the animalcule. These vesicles the reader may readily distinguish in many of the drawings contained in the first six plates, and part of the seventh, which represent animals of the class Polygastrica. Like any other division of nature, some of the members composing it exhibit the essential characteristics of the class more prominent than others, and thus the genera Kolpoda and Paramecium contain the largest forms in which these vesicles exist. The reader will do well to refer to the drawings of these genera, which he can readily

do by means of the *List of Infusoria* I have furnished at the end of this part.

The older naturalists considered these vesicles as the ova; and Baron Gleichen made many experiments to endeavour to see their expulsion, but without success. This idea of the Baron's respecting the nature of these bodies is the more remarkable, as it is to him we owe the original experiments of feeding animalcules with coloured food; and the fact of these parts becoming immediately coloured, while the surrounding portions remain transparent, could scarcely have escaped his notice.

From the observations of Dr. E., these globular vesicles appear to be distinct stomachs, of which a single animalcule belonging to this class possesses many, as noticed in another place. When one of these stomach-cells, or sacs, has been filled with coloured food, and its situation carefully noted, in a short time the coloured spot will have changed its locality, and hence some naturalists will not admit of separate and distinct sacs or cavities, but maintain that the interior of the creature is one large digestive cavity, and that the globular mass of coloured particles has merely changed its position. To this objection, Dr. E. remarks, that he has distinctly observed a sac to fill, and then the particles to pass singly into another, and so on, until the nutritive portions having been imbibed by each cell in succession, the refuse is expelled by the animalcule. That few observers have noticed this process is not remarkable, as it requires stedfast and incessant observation of a particular animalcule for some time, while a contraction of them, or a turning upon their axis, may mislead, or even a slight pressure or

other injury loosening these cells, may occasion a voluntary change of place. Another objection to their being separate sacs or cells for the purpose of digestion is, that observers have not seen the canal or tube connecting them together; this Dr. E. admits is the case in many species, owing to its extreme tenuity. Also, that from its peculiar office, namely, the transmission of the food from one cell to another only, like the oesophagus in large animals, the tube possesses a contractile action, so that the difficulty of detection is augmented. Dr. E. affirms he has distinctly seen their canals while the food has been passing from one stomach cell to another; and in all his works, except *Die Infusionsthierchen*, has presented us with drawings of them, and the manner in which they connect all the cells together. For observations of this kind, it will be advisable to select a large specimen of either of the following species:—Chilodon cucullulus, Trachelius ovum, Vorticella chlorostigma, or convallaria, Opercularia articulata, or Stylonychia mytilus.

Again, the position of the discharging orifice has assisted in the erroneous supposition of the excluded substance being ova, for this orifice is not situated in any certain relation to the mouth; for sometimes one orifice is common to both purposes, as in the fresh water Polype, and some other large creatures. In other Polygastrica, it is either situated anteriorly, posteriorly, or laterally, and this again may be either on the superior or inferior side. On this character, Dr. E. has founded the subdivision of the class into families, as given in Part II. of this work.

Anxious to lay before the reader an impartial statement of this question, I shall, before proceeding with any

general remarks on the Polygastrica, introduce here translations of the observations of the most distinguished German botanist of the day, and likewise those of a celebrated French naturalist, while the observations of Professor Rymer Jones, the only Englishman that has given an opinion on this subject, will be found in his work, and those of naturalists relating to particular families, I have inserted under those divisions.

OBSERVATIONS ON THE DIGESTIVE ORGANS OF INFUSORIA.

By F. J. Meyen, M.D.

"All naturalists are aware that Gleichen, in 1781, tried to make certain Infusoria eat carmine, and observed next day that they had several large red granules in the interior of their bodies. He thence concluded that they had swallowed the colouring matter. He likewise noticed that these coloured granules afterwards made their escape by another opening. Gleichen has figured these red granules very accurately; each of them is in the centre of a particular circle, the nature of which he does not explain. At a later period, M. Ehrenberg made the same remark, and he thence concludes that the Infusoria have several stomachs, which, in one section, are destitute of an intestinal canal, while in others they not only possess canals, by which they communicate with each other, but lateral appendages, which besides terminate in a coecum. In consequence of these discoveries, these Infusoria were designated by the name of Polygastric animals. M.

Ehrenberg believes that he has proved that their stomachs are filled one after another, and he has figured, more or less completely, the intestines which form the communication between the different stomachs.

"Many observers have already questioned these assertions of M. Ehrenberg (see the memoir of M. Dujardin, on this subject, in the 10th volume of the *Annales des Sciences Naturelles*). For my own part, I never admitted them, because, in the first place, I never could see the intestines which form the communication between the stomachs, and likewise because I have observed, many years since, that these supposed stomachs were moving in the interior of the body of many species with great rapidity, in the same manner as the granules which circulate in the joints of the chara. I have often seen vorticelles with nine or ten large globules of indigo in the belly, which always moved round a centre, and thus shewed, in the most evident manner, that they could not have a communicating canal between the stomachs, provided with an oral orifice and an extremity directed to the mouth.

"But it will be asked, what are these vesicles and balls of the same diameter existing in the bodies of the Infusoria, and which have been taken for stomachs? This question I have continued to ask myself, till an attentive and long-continued investigation has enlightened me as to their origin.

"The true Infusoria are vesicular beings, whose interior are filled with a mucous substance; the thickness of the membrane forming the vesicle can easily be ascertained in some of these animals; and in many species I have

noticed in this membrane an obvious spiral structure, which establishes a complete analogy between it and cellular vegetables. In the large Infusoria, a cylindrical canal (the oesophagus) obliquely traverses the membrane which forms the animal. The lower extremity of this canal dilates, more or less, when the animal has taken food, even till it attains the dimensions of the balls which are found in the interior of these same Infusoria.

"The inner surface of this part of the intestinal canal is provided with cilia, which turn round not only the alimentary substances, but also foreign bodies, till they have acquired a spherical form. During the formation of this ball, the stomach (for it is evident we must distinguish this organ by that name) has a free communication with the oesophagus, and by means of the ciliary apparatus found at the exterior, new alimentary substances are introduced into this canal, and pushed as far as the stomach, but I could not satisfy myself whether the oesophagus was likewise beset with cilia in the part which separates the stomach from the buccal orifice. When the ball has acquired the size of the stomach, it is expelled by its other extremity and pushed into the cavity of the animal. It then forms a new ball, if any solid substances exist in the surrounding liquid. This second ball is itself pushed into the interior of the cavity of the animal, and drives before it the first ball along with the mucosities between the two; the successive formation of similar balls, by the matter received into the animal, continues in the same manner, without interruption. It is the simultaneous existence of many of these balls that made M. Ehrenberg believe that these animals were

polygastric. If solid substances do not exist in the surrounding liquid, then the balls are less solid, and they appear in the forms which they present in the Infusoria plunged in colourless liquids. In this case, the balls are composed of a small number of particles, and principally of a considerable mucous mass, which unites them. Sometimes two balls of this kind are so pressed against each other by the contractions of the animal, that they at last unite.

"If you wish to follow the formation of these balls, it is necessary to commence these observations at the moment when the Infusoria are plunged into the coloured liquid. The deglutition of the coloured particles takes place very quickly, often in about half a minute, and the coloured balls issue one after another from the stomach, and are pushed downwards along the internal wall of the cavity of the animal. In the genera Paramecium, Kerona, and Vorticella, the new ball pushes the preceding before it, along with the mucosities between them, in such a manner that the first rises along the opposite wall, returns to the other extremity of the cavity, and is pushed downwards on the other side. The balls thus accumulate in succession till they are expelled one after the other by the anus. The number of these balls is often so considerable, as to fill the whole cavity of the animals, and so close together, that they form a large mass, which turns slowly upon itself, as among the Vorticella.

"This rotation is the result of the force with which the newly-formed ball is pushed from the stomach into the cavity, and moves along the under side of the preceding ball. In other cases, where there are not yet

many balls, we likewise remark the circular rotation alluded to, but I cannot, in this instance, say what is the cause of it.

"Thus, in the true Infusoria, the substances which they absorb are introduced into the abdominal cavity in the form of balls, and from these the stomach extracts the nutritive substances. The residue remains in these same balls, the mucosities interposed are re-absorbed, and even in the interior of the stomach the particles of the ball are disintegrated, although this happens but seldom.

"What is the nature of those vesicular cavities, of such great numbers, and so variable in size, which appear in the interior of the Infusoria? They are not stomachs, they possess nothing in common with the balls of which we have spoken, although the latter may get into them singly, but this can only be considered as accidental.

"We may trace the formation of these cavities, and perceive their sudden and complete disappearance, with as much ease as the formation of the balls. Nay, more, it is sometimes possible to see how one of these cavities moulds itself over a ball, and speedily afterwards disappears. The microscope shows that these cavities are not lined with a particular membrane, but are mere excavations of the pulpy substance. They likewise often appear very near the inner surface of the membrane which forms the skin of the animal, and some of them increase to such a size that their diameter is equal to the third or the half of that of the entire cavity of the Infusoria. The slight refraction which the rays of light undergo at their circumference proves that these cavities are not filled with air, but by a liquid; and in the large Infusoria, it is

easy to satisfy ourselves that they do not open on the exterior. Similar cavities are formed in the mucus of true cellular plants, particularly in certain aquatic Cryptogamia.

"My botanical labours prevent me from carrying these researches farther, but enough has been said to induce the naturalist to pursue them. They require a great degree of perseverance, for it is not easy to establish these facts in all Infusoria, but they are of high importance, since the order Polygastrica has already been admitted into many modern treatises on Zoology."—(*Ed. Phil. J. vol.* xxviii.)

Resumé of "Du Jardin sur les Infusoires dans les Annales des Sciences Naturelles."

"The Infusoria (leaving out of the question the Systolides or Rotateurs, which are much more elevated in the scale of animals, and the Bacillaria, which, along with the Closteria, are more nearly related to the vegetable kingdom) have their origin, for the most part, from unknown germs, in artificial and natural infusions, stagnant water, and rivers, or such portions as rest over vegetable remains—no other mode of propagation, except self-division, being well ascertained. The fleshy substance of their bodies is dilatable and contractile, like the muscular flesh of the superior animals, but present no absolute trace of fibres or membrane, appearing, on the contrary,

homogeneous and diaphanous, save in the cases where the surface appears reticulated from contraction.

"The fleshy substance of the Infusoria, isolated by tearing, or by the death of the animalcule, appears in the liquid as lenticular discs or globules, which refract light but slightly, and are capable of forming spontaneously, in their substance, spherical cavities, analagous, in appearance, to the vesicles of the interior. The vesicles formed in the interior of the Infusoria are destitute of a proper membrane, and can contract even to so great an extent as to disappear, or many amalgate or incorporate, as it were, together. Some are produced at the base of a sort of mouth, and are destined to contain the water swallowed with the aliments; they run a long, a certain course, in the interior, and contract and leave nothing in the middle of the fleshy substance except those particles not digested, or they can evacuate their contents externally, by a fortuitous opening, which may be reproduced several times, although not identical towards the same point, and which may lead to the belief of the presence of an anus.

"The vesicles containing the aliments are independent, and neither communicate with an intestine nor with each other, save in those cases where two vesicles incorporate together.

"The other vesicles, which contain nothing but water, are formed much nearer the surface, and appear to be able to receive and expel their contents through the meshes of the tegument.

"We may consider them, along with Spallanzani, as respiratory organs, or at least as intended to multiply the points of contact of the interior substance and the surrounding fluids.

"The external organs of motion are flagelliform filaments, or vibratile cilii, or cirri, more or less voluminous, or fleshy prolongations, which (except those which are more or less consistent) appeared formed of the same living substance, and are contractile themselves, throughout the whole of their extent. None are dermoid or corneaceous, nor secreted by a bulb, except some siliceous or horny capsule or shells, and the bundles of horny spiculi which invest the mouth of certain species. All portions of the Infusoria decompose almost immediately in water, after the death of the animal.

"The eggs of the Infusoria, their generative organs, their organs of sense, their nerves and vessels, cannot be exactly determined, and every thing inclines one to believe that these animalcules, although endowed with a degree of organization, in accordance with their mode of life, cannot possess the same systems of organs as do the superior animals."

Having presented the reader with the opponents' own arguments to the classification I have adopted, I shall proceed at once to take a general survey of this class, remarking that whatever be the fate of the Polygastrica (and some portions are certainly objectionable), I am convinced an arrangement is yet to be discovered that will supersede it.

The Polygastrica constitute a natural group of animals, and are as satisfactorily distinguished as any other class. Touching their dimensions, none exceed the 1-12th of an inch in length, and some of the smaller species (belonging to the genera Monas, Bodo, Bacterium, and the single individuals of the Vibrio,) even when full grown, are

but the 1-2000th part of that measure; indeed, so minute must be many of the young of these Infusoria, that they cannot be recognised by our microscopes. The genera Stentor and Spirostonum, on the other hand, contain species as large as the greater wheel animalcules (Rotatoria), and are easily to be distinguished by the naked eye. Again, others, individually so small as to be almost invisible, form, when aggregated, green, red, yellow, blue, brown, and black-coloured masses of great extent. Thus, the clusters of some species in the families Vorticella and Bacillaria increase to such an extent that they attain a size of several inches, resembling Polypi. The Micromega forms cartilaginous arborescent masses, which have been looked upon by some as Fuci, Algæ, &c.; Gallionella and Setrizonema, as also Epystilis grandis, often form masses several feet in length.

The greater number of animalcules belonging to this class are found in fresh water; numbers inhabit the salt water of the ocean; and some live in astringent solutions, even those containing much tannin. They are found in fluids produced by animal secretions; moist earth, too, is another situation in which some members of this class are to be found. As an instance of the later habitat, there has been recently found some earth near Newcastle almost entirely composed of living species of the genus Bacillaria, and other loricated Infusoria. It is highly probable that some kinds reside in the vapour of the atmosphere, in which, from their light weight, they may be raised in countless multitudes, and blown about by the wind in invisible cloud-like masses.

It is remarkable, that one-half the families belonging to

this class are loricated, and the other half illoricated. Of the former, the most curious discovery, of late, is that by M. Fischer, of the siliceous or glass-like covering of many species, who, although the creatures to which they belong may have been dead for thousands of years, yet these remains inform us of the local conditions of the soil at the time they existed.

These shell-like coverings are often found in large masses, covering many miles of the earth's surface, and occur, when indurated and mixed with argillaceous and other earths, in the form of siliceous slate-rocks, &c. These remains of the primeval inhabitants of our globe are records in the pages of history, penned by Infinite Truth, unbiassed by ignorance or prejudice, and form some of the first fruits of the effective application of achromatic glasses to our microscopes.

Some of these shell-like coverings have been preserved without any admixture of other matters, and form masses of delicate white powder (*Berg-Mehl*), with which the cupidity of man, in situations where it can be procured, as Lapland, has induced him to adulterate the material which is so truly said to constitute the staff of life.

The antiquarian has also brought the microscope to bear in his researches, and by the discovery of the existence of these shelly remains in various ancient articles of pottery, and the remains of similar species in the clay in the vicinity in which they occur, has proved that they were made on the spot, and not imported from the higher civilized nations of that day, as had been previously supposed.

Section XXIII.—*Reproduction of Polygastrica.*

Monas vivipara is the only species of this class that is viviparous, though some moving granules observed amongst the Bacillaria have been supposed to extend this condition. With this exception, they may be termed oviparous, though besides the formation of eggs, which is a very fertile mode of increase, they also propagate, by means of a self-division of the body of the animalcule, into two or more individuals; also, by the growth of gemmules, or buds, upon the parent. These various modes of propagation account for their almost incomprehensible increase of number in a very short space of time, and which has often astonished observers.

In the genus Closterium, the curious formation of double gems has been observed by Ehrenberg, and is figured in plate I. *fig.* 67. That observer remarks, that this accounts for "the astonishing great fertility or capacity of increase of microscopic animals, according to which an imperceptible corpuscle can become, in four days, *one hundred and seventy billions,* or as many single individual animalcules as contained in two cubic feet of the stone from the polishing slate of Bilin. This increase takes place by voluntary division, and this is the character which separates animals from plants. It is true that the gemmation in plants, especially, in very simple cells, is at times very similar to the division in animals; but this relates to the form, not the formation. A vegetable cell, apparently capable of self-division, always became one, or contemporaneously

many exterior warts (gems), without any change in its interior. An animal, which is capable of division, first doubles the inner organs, and subsequently decreases exteriorly in size. Self-division proceeds from the interior towards the exterior, from the centre to the periphery; gemmation, which also occurs in animals, proceeds from the exterior towards the interior, and forms first a wart, which then gradually becomes organized."—(*Annals Nat. Hist.* v. ii.)

Section XXIV.—*Vascular System.*

In no creature of this class can a vascular system be satisfactorily demonstrated:—that thought to have been such in Paramecium aurelia was merely clusters of ova.

Section XXV.—*Organs of Sensation.*

Of these, the presence of eyes are all that are demonstrated, though there can be no doubt those of touch, sensation, &c., exist.

In forty-eight species, included under the families Monadina, Cryptomonadina, Volvocina, Astasiæa, Dinobryina, Peridinaea, and Kolpodea, eyes are observable, and the colour of the pigment is red in all cases, except one (Ophryoglena), in which it is almost black. In connection with the visual organs of Amblyophis and Euglena, nervous ganglia have been seen, which constitute the only traces of the evidence of a nervous system.

Section XXVI.—*Digestive System of Polygastrica.*

The most remarkable feature in this class of beings is the reception of food. In most creatures it enters one common cavity, and therefore forms one mass. In the Nais (see *Notes on Natural History*, plate 7), and some other animals, the alimentary canal is enlarged at intervals, so that it may be termed a percurrent digestive organ; but in the Polygastrica, it appears to be a very compound organ, sometimes consisting of upwards of two hundred cavities or sacs, as in the Paramecium, while the smallest number is four, and this occurs in the genus Monas.

The manner in which these sacs are arranged is various, though all may be disposed under two grand divisions, namely:—

Anentera, or those without a true alimentary canal, in which the refuse of the food is regurgitated, as in the Zoophites, of which the *fresh water Polypi* (*Notes on Nat. Hist.* pl. 6) may be taken as an example. It will appear, that the Infusoria belonging to the first twelve families include the Anentera; these possess but one orifice for the reception and expulsion of food; and although the mode in which the stomach cells are attached together is not satisfactorily determined (and this I infer from the omission of illustrative figures of structure in *Die Infusionsthierchen*), yet observation leaves little doubt that no true alimentary canal exists.

Enterodela, or those Polygastrica possessing a true alimentary canal, constitute the ten remaining families. In this division, the alimentary canal, during its course, sends forth, at intervals, short branches, each of which is termi-

nated by a digestive sac. In the families Vorticellina and Ophrydina, the two ends of the alimentary canal approach each other, and form but one external opening. In the Enchelia and Colepina, the orifices are at the opposite extremities of the body; in Trachelina, Ophryocercina, and Aspidiscina, they terminate obliquely with respect to each other; and the remaining families are distinguished from the preceding by both openings being situated on the under side of the animalcule.

SECTION XXVII.—*Geographical Distribution of Polygastric Infusoria.*

This is the most universal of the Animal Kingdom. It is known to extend over the whole of Europe, the north of Africa, the west and north of Asia, and species have also been observed in America. The largest and most generally-distributed family of this class is the Bacillaria, its species equalling one-fourth of the whole.

Fossil states of this curious family are known in Europe, Africa, the Isle of Bourbon, the Isle of Lucan, amongst the Philippines, and America. These remains enter into some of the new sand-stone formations; also into the layers of flints of the secondary formations, certain porphyritic structures, &c.

Some objections have been made by a few eminent naturalists to certain families of Dr. E.'s Infusoria. The most important of these I have inserted under their several heads in Part II. Those of Dr. Meyen, which are unknown to the English reader, contain many important remarks, and are worthy of special notice.

Section XXVIII.—*Class* Rotatoria.

This tribe of beings possess so complete an organization, that in a correct arrangement of the animal kingdom, it would take its station far above many others, whose members are of much larger magnitude.

The comparatively large size of the Rotatoria, the definite situation of the ova, and the simplicity of their digestive system, has enabled the microscopic observer to ascertain with certainty, in many cases, every part of their internal structure. As a tribe, it appears to me more natural than that of the Polygastrica; at least there are no such doubtful families as we find in the latter, namely, the Closterina, Bacillaria, &c. Indeed, the only exception that I think can be taken is the genus Stephanoceros, which some naturalists class along with the zoophites.

The Rotatoria mostly inhabit water; but immersion in that element does not appear to be essential to their existence. They often reside in damp or moist earth; and the Rotifer vulgaris, and some other species, are known to inhabit the cells of Mosses and Algæ.

Seection XXIX.—*Muscular System.*

In this class of Infusoria, a muscular system subservient to the functions of locomotion, nutrition, &c., is well developed, and the integuments being transparent, render their structure and situation distinctly visible under the microscope, without dissection. The principal muscular

member is a foot-like non-articulated process, situated at the ventral surface of the posterior part of the body. This member is usually called the tail; but being situated anterior to the discharging orifice, is not properly such. It has usually the faculty of being able to slide one part within another, and presents to the observer the same effect as the moving of the sliding tubes of an opera-glass, or telescope. The extremity is often formed in such a manner that the creature can cause itself to adhere to any substance, by forming an exhausted cavity within the disc-like extremity, as is the case with the leech and some parasitical acari found on beetles. Sometimes the termination of this false foot has two or more toe-like processes. By the construction of this member, the creature is enabled to attach itself, while the anterior part is moving about in search of provender, and likewise to employ it as an instrument of progression, by alternately contracting and elongating it, and fixing itself by it and the mouth. Muscles for moving the body, and also the rotatory organs, are mostly visible; these are known by their thickening during contraction, and dilating when elongated.

Section XXX.—*Nutritive System.*

The alimentary canal is mostly simple in all the Rotatorial Infusoria. It is sometimes expanded near the middle, in which case it may be said to have a true stomach, the constricted commencement being an oesophagus, and the long narrow termination a rectum.

The manducatory, or chewing apparatus, situated at the

commencement of the oesophagus, consists of a hard bulb, somewhat resembling the gizzard of birds; it is composed of two parts, the inner surface of each being, in 48 genera, furnished with teeth, which, by pressure, can be detached. Their number and arrangement form excellent characters for the systematist, and therefore I have introduced figures of them, with the oesophagal bulb, to illustrate several of the genera possessing them. This bulb, it is worthy of notice, is the first part of the young that is visible within the egg. Beneath this bulb, and attached to the oesophagus, or upper part of the stomach, is a pair of glands, usually of an oval form, sometimes, though rarely, cylindrical, or forked; these are considered as the pancreas. In some genera, gall ducts are also seen (Enteroplea). The stomach in some genera (Notommata) is furnished with biliary glands.

Section XXXI.—*The Reproductive System.*

This, in most respects, resembles that of birds, but both sexes are united in the same individual. They deposit only a few eggs at a time. The size of the egg is about 1-36th that of the parent, and the young of those in which incubation is completed before expulsion is sometimes two-thirds.

Although the Rotatorial Infusoria are not endowed with the various faculties of reproduction possessed by the Polygastrica, yet their vast increase by eggs only would astonish most persons who have not considered this subject. Dr. Ehrenberg informs us that he insulated a

single specimen of Hydatina senta, and kept it in a separate vessel for eighteen days, that during this interval it laid four eggs per day, and that these young, at two days old, lay a like number, so that, when circumstances are favourable, one million individuals are obtained from one specimen in 10 days; that, on the eleventh day, this brood will amount to four millions, and on the 12th day to sixteen millions. Although the fecundity of this Rotatoria is the greatest that has been tested by direct experiment, yet in the large Polygastrica, as the Paramecium aurelia, a single specimen in one day is ascertained to increase to eight, by simple transverse division of the body only; so that, if we take into this account the other modes of the increase of this creature, namely, by eggs, often in masses like the spawn of fish, and again by buds growing from the sides of the body, it is clear, in a very few days, all attempt at an expression of their number must fail.

Section XXXII.—*Vascular System.*

In several of the Rotatorial Infusoria are observed transverse vessels, which have the appearance of articulalations. In others, these vessels resemble a net work (see pl. ix. *fig.* 419), which is more or less distinct, below the edges of the mouth, and connected by free longitudinal ones to the interior ventral surface of the body.

Oval tremulous little bodies are in some species observed attached to a free filament-like tube (Notommata, *fig.* 416), generally disposed longitudinally within the body of the animalcules. Sometimes these little bodies are

attached to the two sexual glands (Hydatina). Dr. Ehrenberg considers their function analagous to gills, and that the tremulous motion is occasioned by the laminae, or leaflets, which compose them. For the reception of water into the interior of the body, for these organs to act upon, there is an opening at the anterior part of the body, while some species effect this purpose by means of one or two spur-like processes or tubes, emanating from the neck (see *fig*. 487), and by which water for the purpose of respiration may be admitted or rejected.

Section XXXIII.—*Organs of Sensation and Nervous System.*

The Infusoria are not considered to possess a true nervous system, but in many of the species having eyes there appears one or two masses attached to them, which Dr. E. thinks are similar to nervous ganglia and nervous fibrillae. The eyes vary in number ; they are usually of a red colour ; in some, they are placed upon a ganglion, and are freely moveable beneath the transparent superficial envelope of the body.

Section XXXIV.—*Geographical Distribution of Rotatorial Infusoria.*

So far as observation extends, they do not appear to be confined to any particular part of Europe, and they have been found in the north of Africa, the north and west of Asia, and in Carolina in America.

A LIST

OF

THE INFUSORIA

DESCRIBED IN

PART II.

SHOWING THE ORDER OF ARRANGEMENT OF THE SEVERAL FAMILIES, GENERA, AND SPECIES, AND THE DRAWINGS ILLUSTRATING THEM.

The Number preceding the Name refers to that under which it is described; the Numbers following refer to the Drawings of them in the Plates; and the stars (*) indicate those species most common in infusions.

CLASS I. POLYGASTRICA.

FAMILY I. MONADINA.

I. Monas — *Plate* I.

1 crepusculum (**), *group* 1
2 termo (***)
3 guttula (*)
4 vivipara
5 grandis
6 bicolor
7 ochracea
8 erubescens
9 vinosa
10 kolpoda
11 enchelys
12 umbra
13 hyalina
14 gliscens (*)
15 ovalis
16 mica
17 punctum, *group* 2
18 cylindrica
19 Okenii
20 deses
21 socialis
22 flavicans
23 simplex
24 inanis
25 scintillans
26 Dumalii

II. Uvella — *Plate* I.

27 virescens
28 chamaemorum
29 uva
30 atomus
31 glaucoma (**), *cluster* 3, and *fig.* 4, 5, 6
32 bodo

III. Polytoma

33 uvella, *fig.* 7, 8, 9, 10, 11

IV. Microglena

34 punctifera
35 monadina, *fig.* 12, 13, 14

V. Phacelomonas

36 pulvisculus

VI. Glenomorum

37 tingens, *fig.* 15, 16, 17

VII. Doxococcus

38 globulus
39 ruber, *group*
40 pulvisculus
41 inaequalis

VIII. CHILOMONAS *Plate* I.

42 volvox
43 paramecium (*), *group* 19
44 destruens

IX. BODO

45 socialis (**)
46 vorticellaris

BODO *Plate* I.

47 didymus
48 saltans (*)
49 grandis
50 intestinalis, *group* 20
51 ranarum
52 viridis
53 oystea

FAMILY II. CRYPTOMONADINA.

X. CRYPTOMONAS

54 curvata
55 ovata, *fig.* 21, 22, 23
56 erosa
57 cylindrica
58 ? glauca
59 ? fusca
60 lenticularis

XI. OPHIDOMONAS

61 jenensis

XII. PROROCENTRUM

62 micans, *fig.* 24, 25

XIII. LAGENELLA

63 euchlora, *fig.* 26, 27, 28

XIV. CRYPTOGLENA

64 conica, *group* 29
65 pigra
66 carulescens

XV. TRACHELOMONAS

67 nigricans
68 volvocina, *fig.* 30 to 33
69 cylindrica

FAMILY III. VOLVOCINA.

XVI. GYGES

70 granulum, *fig.* 34
71 bipartitus
72 sanguineus, [*plate* xii. *group* 532]

XVII. PANDORINA

73 morum, *fig.* 35, 36, 37
74 ? hyalina

XVIII. GONIUM

75 pectorale, *fig.* 38 to 42
76 punctatum
77 ? tranquillum, *fig.* 43
78 ? hyalinum
79 ? glaucum

XIX. SYNCRYPTA

80 volvox, *fig.* 44, 45, 46

XX. SYNURA

81 uvella, *fig.* 50, 51

XXI. UROGLENA

82 volvox, *fig.* 53, 54

XXII. EUDORINA

83 elegans, *fig.* 47

XXIII. CHLAMIDOMONAS

84 pulvisculus (**), *group* 52

XXIV. SPHAEROSIRA

85 volvox, *fig.* 48, 49

XXV. VOLVOX

86 globator, *fig.* 55, 56, 57
87 aureus
88 stellatus

FAMILY IV. VIBRIONIA.

XXVI. BACTERIUM

89 triloculare (*), *group* 58
90 ? enchelys
91 ? punctum

XXVII. VIBRIO

92 lineola (**)
93 tremulans (*)
94 subtilis
95 rugula (***)
96 prolifer
97 bacillus (*), *group* 59

XXVIII. SPIROCHAETA

98 plicatilis, *fig.* 60

XXIX. SPIRILLUM

99 tenue
100 undula (**), *fig.* 61
101 volutans (*)
102 bryozoon, [*plate* xii.] *fig.* 520 to 531

XXX. SPIRODISCUS

103 fulvus, *fig.* 62

FAMILY V. CLOSTERINA.

XXXI. Closterium *Plate* I.

104 lunula
105 moniliferum
106 Dianae
107 acerosum, *fig.* 63, 64, 65
108 trabecula
109 digitus
110 attenuatum
111 cornu

Closterium *Plate* I.

112 ? cylindrus
113 margaritaceum
114 turgidum, *fig.* 66
115 lineatum
116 striolatum
117 setaceum, *group* 67
118 rostratum
119 ? inaequale

FAMILY VI. ASTASIAEA.

XXXII. Astasia

120 haematodes, *fig.* 68
121 flavicans
122 pusilla, *fig.* 69
123 ? viridis
124 navalis, [*plate* xii.] *fig.* 533

XXXIII. Amblyophis

125 viridis, *fig.* 70

XXXIV. Euglena

126 sanguinea, *fig.* 71, 72, 73
127 hyalina
128 deses
129 viridis
130 spirogyra
131 pyrum, *group* 74
132 pleuronectes

Euglena

133 longicauda, *fig.* 75, 76
134 triquetra, 77
135 acus, *group* 78
136 rostrata

XXXV. Chlorogonium

137 euchlorum, *group* 79

XXXVI. Colacium

138 ? vesiculosum, *group* 80
139 stentorinum

XXXVII. Distigma *Plate* II.

140 ? tenax
141 proteus, *group* 81
142 viride
143 planaria
144 dinobryina

FAMILY VII. DINOBRYONIA.

XXXVIII. Epipyxis *Plate* II.

145 utriculus, *group* 82

XXXIX. Dinobryon

146 sertularia, *fig.* 83, 84
147 ? sociale

FAMILY VIII. AMOEBAEA.

XL. Amoeba

148 princeps, *fig.* 85, 86, 87
149 verrucosa

Amoeba

150 diffluens
151 radiosa, *fig.* 88, 88′

FAMILY IX. ARCELLINA.

XLI. Difflugia

152 proteiformis, *fig.* 89 to 91
153 oblonga
154 acuminata
155 enchelys

XLII. Arcella

156 vulgaris

Arcella

157 aculeata, *fig.* 92, 93, 94
158 dentata
159 ? hyalina

XLIII. Cyphidium

160 aureolum, *fig.* 95 to 98

FAMILY X. BACILLARIA.

XLIV. Desmidium

161 Swartzii
162 orbiculare
163 hexaceros, *group* 99
164 bifidum
165 aculeatum

Desmidium

166 apiculosum

XLV. Staurastrum

167 dilatatum, *fig.* 100, 101
168 paradoxum, *fig.* 102, 103

XLVI. PENTASTERIAS *Plate* II.
169 margaritacea, *fig.* 104

XLVII. TESSARARTHRA
170 moniliformis, *fig.* 105, 106

XLVIII. SPHAERASTRUM
171 pictum
172 quadrijugum

XLIX. XANTHIDIUM
173 hirsutum [*plate* xii.] *fig.* 512
174 aculeatum, *fig.* 109
175 fasciculatum
176 furcatum, *fig.* 110
177 ? ramosum, *fig.* 511, 515
178 ? difforme, *fig.* 111, 513, 514
179 crassipes
180 tubiferum

L. ARTHRODESMUS
181 quadricaudatus
182 pectinatus
183 acutus
184 convergens, *fig.* 112, 113
185 octocornis
186 truncatus

LI. ODONTELLA
187 desmidium, *fig.* 108
188 ? filiformis, *fig.* 107
189 ? unidentata

LII. MICRASTERIAS
190 tetras
191 coronula
192 Napoleonis (hexaetis), *fig.* 117, 118
193 heptactis, *fig.* 114
194 Boryana, *fig.* 115, 116
195 angulosa
196 rotula
197 tricyclia
198 elliptica

LIII. EUASTRUM
199 rota, *fig.* 121, 122, 123
200 apiculatum
201 crux melitensis, *fig.* 124
202 pecten
203 verrucosum, *fig.* 125
204 ansatum
205 margaritiferum *fig.* 126
206 botrytis
207 integerrimum

LIV. MICROTHECA
208 octoceros, *fig.* 119, 120

LV. PYXIDICULA
209 operculata, *group* 127
210 globator, [*plate* xii.] *fig.* 506 to 510.

LVI. GALLIONELLA *Plate* III.
211 lineata, *fig.* 128
212 nummuloides
213 varians, *group* 131
214 moniliformis
215 aurichalcea
216 ferruginea, [*plate* ii.] *fig.* 129, 130
217 distans
218 sulcata, [*plate* iii.] *group* 131

LVII. ACTINOCYCLUS
219 senarius, *group* 132
220 octonarius

LVIII. NAVICULA *Plate* III.
221 Phoenicenteron, *group* 139
222 gracilis
223 ? pellucida, *group* 140
224 acus, *group* 147
225 umbonata
226 fulva
227 amphisbaena, *group* 141
228 platystoma, *fig.* 142
229 nodosa, *fig.* 143
230 trochus
231 follis
232 trinodis
233 cari
234 ? quadricostata
235 baltica, *fig.* 144
236 hippocampus, *group* 145
237 sigma, *group* 146
238 scalpum
239 curvula
240 arcus
241 sigmoidea, *group* 148
242 viridis, *fig.* 133 to 136
243 macilenta
244 viridula
245 inaequalis, *group* 154
246 gibba
247 ? crux
248 ? glans
249 capitata
250 dicephala
251 lanceolata
252 ? librile, *group* 155
253 ? splendida, *fig.* 150 to 152
254 ? bifrons
255 striatula, *fig.* 137, 138
256 ? undulata, *fig.* 149
257 ? constricta
258 ? amphora, *fig.* 153
259 ? lineolata

LIX. EUNOTIA *Plate* III.

260 turgida, *fig.* 156 to 161, except in *group* 157, those marked by a cross
261 Westermanni, in *group* 157, those figures marked by a cross
262 zebra
263 granulata, *fig.* 165
264 ? faba
265 arcus
266 diodon
267 triodon, *group* 164
268 tetraodon
269 pentodon
270 diadema
271 serra

LX. COCCONEÏS

272 scutellum, *fig.* 162, 163
273 undulata
274 placentula
275 pediculus
276 ? finnica
277 ? clypeus [*plate* xii.] *fig.* 516 to 518

LXI. BACILLARIA

278 paradoxa, *fig.* 166, 167
279 vulgaris, *fig.* 168
280 pectinalis
281 elongata, *fig.* 169
282 cuneata, *fig.* 170
283 Cleopatrae
284 ? tabellaris
285 flocculosa
286 seriata
287 Ptolemaei

LXII. TESSELLA

288 catena, *fig.* 180 to 182
289 arcuata
290 interrupta

LXIII. FRAGILARIA

291 grandis, *fig.* 171
292 rhabdosoma, *fig.* 173, 174
293 turgidula, *group* 172
294 multipunctata
295 bipunctata, *fig.* 175
296 angusta
297 scalaris
298 diopthalma
299 pectinalis, *fig.* 176

LXIV. MERIDION

300 vernale, *fig.* 177 to 179
301 ? panduriforme

LXV. ISTHMIA *Plate* IV.

302 obliquata
303 enervis, *fig.* 183

LXVI. SYNEDRA

304 ulna, *group* 184
305 capitata, *group* 185'
306 gallionii
307 fasciculata
308 lunaris, *group* 185
309 bilunaris

LXVII. PODOSPHENIA

310 gracilis, *fig.* 186
311 abbreviata
312 cuneata
313 ? nana

LXVIII. GOMPHONEMA

314 truncatum, *fig.* 187 to 190
315 capitatum
316 gracile
317 acuminatum
318 minutissimum
319 clavatum
320 rotundatum
321 discolor
322 ? olivaceum

LXIX. ECHINELLA

323 flabellata, *fig.* 191 to 193
324 splendida
325 ? paradoxa
326 capitata
327 ? abbreviata
328 fulgens

LXX. COCCONEMA

329 Boeckii
330 lanceolatum, *fig.* 194, 195
331 cistula, *fig.* 196 to 198
332 cymbiforme
333 ? gibbum
334 ? fusidium

LXXI. ACHNANTHES

335 longipes
336 brevipes, *fig.* 199 to 202
337 subsessilis
338 exilis
339 minutissima
340 ? inaequalis

LXXII. STRIATELLA

341 arcuata, *fig.* 203, 204

LXXIII. FRUSTULIA

342 appendiculata
343 maritima
344 salina

LXXIV. SYNCYCLIA *Plate* IV.

345 salpa, *group* 206

LXXV. NAUNEMA

346 simplex
347 Dillwynii
348 Hoffmanni
349 arbuscula
350 balticum, *fig*. 207

LXXVI. GLOEONEMA

351 paradoxum

Plate IV.

LXXVII. SCHIZONEMA

352 ? Agardhi, *fig*. 208

LXXVIII. MICROMEGA

353 corniculatum

LXXIX. ACINETA

354 lyngbyi
355 tuberosa
356 mystacina, *fig*. 205

FAMILY XI. CYCLIDINA.

LXXX. CYCLIDIUM

357 glaucoma, *fig*. 209 to 211
358 margaritaceum
359 ? planum
360 ? lentiforme

LXXXI. PANTOTRICHUM

361 enchelys, *fig*. 212

PANTOTRICHUM

362 volvox
363 lagenula

LXXXII. CHAETOMONAS

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368 ? pyritae

LXXXIV. CHAETOGLENA

369 volvocina, *fig*. 216 to 218

LXXXV. PERIDINIUM

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371 pulvisculus
372 fuscum
373 ? pyrophorum

PERIDINIUM

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376 cornutum
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LXXXVI. GLENODINIUM

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385 Roeselü, *fig*. 233, 234
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LXXXIX. UROCENTRUM

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396 citrina
397 microstoma (**)
398 campanula
399 hamata
400 chlorostigma
401 patellina (*)
402 convallaria, [*plate* v.] *fig*. 237, 238, 239
403 picta

XCI. CARCHESIUM

404 polypinum, *fig*. 240 to 245

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409 flavicans
410 leucoa
411 digitalis
412 ? nutans, *fig.* 245, 246
413 botrytis
414 ? vegetans

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XCIII. OPERCULARIA
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XCIV. ZOOTHAMNIUM
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436 difformis

CII. TRICHODISCUS
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CIII. PODOPHRYA
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CIV. TRICHODA
439 pura (*) *fig.* 271 to 273
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441 ovata
442 ? aethiopica

TRICHODA
443 asiatica
444 pyrum

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CIX. COLEPS
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480 intestinalis
481 ? cordiformis
482 lateritia
483 vernalis
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488 ranarum
489 ? aurantiaca

CXIII. SPIROSTOMUM
490 virens, *fig.* 296′

SPIROSTOMUM *Plate* VI.
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CXIV. PHIALINA
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CXV. GLAUCOMA
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CXVI. CHILODON
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497 aureus
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TRACHELOCERCA
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CXX. KOLPODA
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509 ? cucullio

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CXXIV. OPHRYOGLENA
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532 acuminata, *fig.* 334, 335
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CXXV. OXYTRICHA
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537 platystoma
538 gibba, *fig.* 336, 337
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OXYTRICHA
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Stylonychia *Plate* VII.
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CXXXI. Himantophorus
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Euplotes
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560 aculeatus
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Chaetonotus
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CXXXIX. Conochilus
570 volvox, *fig.* 365 to 370

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CXLIV. Stephanoceros
575 Eichhornii, *fig.* 383, 383*

CXLV. Limnias
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CL. Hydatina
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588 Reinhardti, *fig.* 397, 398
589 forficula
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CLIII. MONOCERCA

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592 bicornis, *fig.* 399, 417
593 ? valga

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595 syrinx
596 hyptopus
597 parasita
598 granularis
599 petromyzon
600 lacinulata
601 forcipata
602 collaris
603 Werneckii
604 najas
605 aurita
606 gibba
607 ansata
608 decipiens
609 ? felis
610 ? tigris, *fig.* 421
611 longiseta
612 aequalis
613 clavulata
614 tuba
615 brachionus
616 tripus
617 saccigera
618 copeus, *fig.* 416
619 centrura
620 brachyota

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631 aurita
632 catellina
633 conura
634 capitata
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CLIX. TRIARTHRA

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CLX. RATTULUS

638 lunaris, *group* 409

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641 ? marinum
642 ? forcipatum

CLXII. TRIOPHTHALMUS

643 dorsualis, *fig.* 412 to 414

CLXIII. EOSPHORA

644 najas, *fig.* 415
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646 elongata

CLXIV. OTOGLENA

647 papillosa

CLXV. CYCLOGLENA

648 lupus, [*plate* x.] *fig.* 425,* 426
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CLXVI. THEORUS

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653 emarginata
654 ? salpina

CLXVIII. MONOSTYLA

655 cornuta
656 quadridentata, *fig.* 434 to 437
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CLXIX. MASTIGOCERCA

658 carinata, *fig.* 438 to 440

CLXX. EUCHLANIS

659 ? triquetra, *fig.* 441 t0 444
660 ? Hornemanni
661 luna
662 macrura
663 dilatata
664 lynceus, *fig.* 445, 446

CLXXI. SALPINA *Plate* X.
665 mucronata, *fig*. 447 to 453
666 spinigera
667 ventralis
668 redunca
669 brevispina
670 bicarinata

CLXXII. DINOCHARIS
671 pocillum, *fig*. 454 to 456
672 tetractis
673 paupera

CLXXIII. MONURA.
674 colurus
675 dulcis, *fig*. 457 to 459

CLXXIV. COLURUS
676 ? uncinatus (**)

COLURUS *Plate* X.
677 ? bicuspidatus
678 caudatus
679 deflexus, *fig*. 460 to 462

CLXXV. METOPIDIA
680 lepadella, *fig*. 463 to 465
681 acuminata
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CLXXVI. STEPHANOPS
683 lamellaris, *fig*. 466, 467
684 ? muticus
685 cirratus

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687 oblonga, *fig*. 468, 469

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CLXXIX. HYDRIAS
689 cornigera, [*plate* xi.] *fig*. 474

CLXXX. TYPHLINA
690 viridis, *group* 475

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691 vulgaris, *fig*. 476 to 480
692 ? citrinus
693 ? erythraeus
694 macrurus
695 tardus

CLXXXII. ACTINURUS
696 Neptunius, *fig*. 481 to 484

CLXXXIII. MONOLABIS
697 conica *fig*. 485, 486
698 gracilis

CLXXXIV. PHILODINA
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700 Roseola, *fig*. 490
701 collaris
702 macrostyla
703 citrina
704 aculeata, *fig*. 487 to 489
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CLXXXV. NOTEUS
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CLXXXVI. ANURAEA
707 ? quadridentata
708 squamula, *fig*. 495 to 497
709 falculata
710 curvicornis
711 biremis
712 striata
713 inermis
714 acuminata
715 foliacea
716 stipitata, *fig*. 498
717 testudo
718 serrulata
719 aculeata
720 valga

CLXXXVII. BRACHIONUS
721 pala
722 amphiceros
723 urceolaris
724 Rubens
725 Mülleri
726 brevispinus
727 Bakeri
728 polyacanthus, *fig*. 499 to 501
729 militaris

CLXXXVIII. PTERODINA
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731 elliptica
732 clypeata, *fig*. 505

Since the preceding List went to press some new species have been discovered, and ten new genera established; these will be described in the Appendix.

PART II.

CLASSIFICATION AND DESCRIPTION

OF

INFUSORIAL ANIMALCULES.

Class I. POLYGASTRICA.

Note.—Where the creature has been described previously by Müller, the founder of this subject, the letter (M.) in parentheses follows the English one. When the original name of Müller is changed, such precedes the letter (M.) within the parentheses.—The measurements are given in parts of an inch.

This class of animalcules is denominated Polygastric from their possessing a digestive apparatus composed of many globular vesicles, which perform the functions of stomachs. They have no perceptible nervous cords or pulsation. They are hermaphrodite, and increase by a self-division of the creatures themselves, or by the growth of gemmules, or little buds, upon their bodies. Hence their external forms vary. Their locomotive organs consist of processes (often vibratory), but they are destitute of true articulated feet.

The Polygastric animalcules comprehend twenty-two families, whose relations to each other may be seen in the following table:—

Anentera, or without true alimentary canal.	Body destitute of appendages. (No foot-like processes). *Gymnica*	Form of body constant	self-division complete	illoricated or shell-less		Monadina.
				loricated or shelled		Cryptomonadina.
			self-division incomplete, hence formed in clusters	self-dividing on all sides (globular)		Volvocina.
				self-dividing unilaterally (filiform)	illoricated	Vibrionia.
					loricated	Closterina.
		Form of body variable	illoricated			Astasiaea.
			loricated			Dinobryina.
	Foot-like processes variable. *Pseudopoda*	illoricated				Amoebaea.
		loricated	compound foot-like process from one aperture			Arcellina.
			simple footlike process from one or from each aperture			Bacillaria.
	Hairy *Epitricha*	illoricated				Cyclinida.
		loricated				Peridinaea.
Enterodela, with an alimentary canal.	One receiving and discharging orifice only for nutrition. *Anopisthia*	illoricated				Vorticellina.
		loricated				Ophrydina.
	Two ditto orifices, one at each extremity. *Enantitreta*	illoricated				Enchelia.
		loricated				Colepina.
	Orifices situated oblique. *Allotreta*	illoricated	mouth furnished with proboscis, tail absent			Trachelina.
			mouth anterior, tail present			Ophryocercina.
		loricated				Aspidiscina.
	Orifices abdominal. *Catotreta*	illoricated	locomotive organs cilii			Kolpodea.
			——— various			Oxytrichina.
		loricated				Euplota.

Family I.—MONADINA.

The animalcules of the family Monadina are the most minute living creatures which have been discovered by man. They are destitute of an alimentary canal; are illoricated or shell-less, and have an uniformity of body without any appendages issuing from it, cilia not being considered as such. They increase either by a simple and complete self-division of the body into two parts, or by other sections, into four or more individuals. The uniformity or unvarying appearance in their external forms may be considered as one of the principal characteristics of this family; for no Monadina can voluntarily alter the shape of its body, whether into a filiform, knotty, or globular figure, nor can it extend any portion of it, and then contract it again. It is quite evident that they all possess organs of locomotion, nutrition, and propagation, which latter are of the hermaphrodite character. Some of them have a rudimentary eye, but it has never been discerned that they are furnished with a vascular or circulating system, which, however, is not surprising, when we reflect that should they possess it (a supposition by no means to be rejected), the diameters of the tubes of this system would necessarily be of such extreme minuteness as hitherto to have defied investigation.

The groups and figures in *Plate* I., numbered 1 to 20, convey a very fair idea of the appearance of the Monadina. None but microscopes of high magnifying powers can develope their structures; indeed, they cannot be observed accurately with a less amplification than 500

diameters, together with considerable penetration and a good definition.

The family comprises forty-three species, distributed among nine genera, as follow:—

Tail wanting	Lips wanting	Swimming	Eye wanting	Single		Monas.
				Aggregate	Voluntarily	Uvella.
					During division	Polytoma.
			Eye present	Single	Proboscis one or two	Microglena.
					Proboscis many	Phacelomonas.
				Aggregate		Glenomorum.
		Rolling				Doxococcus.
	Lips present					Chilomonas.
Tail present						Bodo.

Genus I. Monas. *The Monads.*—The animalcules of this genus—the true Monads—are described (see the Table) as being deficient of the eye, projecting lip and tail, and always swimming in the direction of the longitudinal axis of the body, their mouth being situated at the anterior part. It is another distinguishing character of the true Monad that it is never seen to cluster with others of its genus, so as to form a berry-like mass, and hence it is designated single, in contradistinction to aggregate. At present, there are twenty-six species of this genus known—two green, two yellowish, three inclining to red, and the remainder colourless; but it should be mentioned, that although there be colour, it must not be regarded as a characteristic to be entirely relied upon. Monads may often be present in water, under inspection, without being seen, through the want of a competent magnifying power; you would seek for them in vain with a power less than

300 diameters, and even this, in some cases, will be found insufficient. They are besides a difficult genus to be accurately determined, not only on account of their exceeding minuteness, but because the young of animalcules of other genera are so likely to be mistaken for them: for instance, the young of the Bacterium, Vibrio, Uvella, Polytoma, Pandorina, Gonium, &c., when they have separated from their clusters, or issued from their common envelopes. And this difficulty in discriminating them will be more likely to happen when they are not observed, whilst undergoing the process of self-division, or when seen in water containing but a small number of them; in which cases, however anxious we may be to ascertain their name, we must often rest contented with an approximation to the truth. When the water swarms with the creatures, the decision will be far easier and more to be relied upon, as the characters are then more easily discoverable from the numerous vital relationships presented to us. The observer may, however, be guided to a certain extent by the following rule:—Suppose that in a drop of water containing species of the genus Vibrio, Bacterium, Uvella, or Polytoma (easily distinguished by their clustering forms), you were to observe separate Monad-like bodies; the probability is that they would be either single forms, or the young of these clustering animalcules, and if there were no great difference in the size of the separate individuals and those forming the clusters, this conclusion would be generally correct; and this rule applies equally to those green Monad-like creatures found amongst the Pandorina and Gonia. The young of the Chlamidomonas pulvisculus is very deceptive, and may often be mistaken

for an illoricated and eye-less green Monad. When Monads are assembled, however, in vast numbers, we may, with a little trouble, almost always arrive at some definite conclusion, but with only a single one, or upon a superficial and hasty examination, the genus cannot be accurately determined.

The only locomotive organ which has been discovered in the Monad genus is the single filiform proboscis issuing from near the mouth. The numerous cilia sometimes apparent thereabouts are nothing more than this proboscis in a state of vibratory or rotatory motion. This organ, Ehrenberg observes, has a twofold office to perform, the one being locomotive and the other to provide the creature with food; hence I term it a purveying organ.

The nutritive apparatus is readily seen in some of the species in its natural state (instance the M. guttula and vivipara), without the aid of coloured food; in others (M. termo, guttula and socialis), it may be demonstrated by this means. It consists of several distinct or separate cells (from eight to twenty) which are not all filled at the same time, and which are, for the most part, invisible when empty, but when distended with a limpid fluid, appear like so many lucid vesicles within the creatures.

The propagative apparatus has been particularly noticed in the species guttula and vivipara. It consists of a vast number of granules formed into a net-like mass, and dispersed generally throughout the creature, and of a comparatively large spherical glandular body, which separates by the process of self-division.

Monads propagate also by another method, namely, by a self-division of the creature, either transversely, as with

the Monas guttula, hyalina, gliscens, Okenii, and socialis; or longitudinally, as with the Monas punctum (see *figure* 2); both methods have been observed with the vivipara. The formation of gemmules has not been perceived in this genus.

Ehrenberg supposes that they are endowed with the faculty of sensation, and that this is shewn by the vibration of the proboscis, and its alternate quiescence when the creature is in a place abundantly supplied with food. In some of the species an eye-like organ has been discerned, but as the species of each genus should be reduced to the rule of a special organ, characterizing a particular genus, these are not considered as true Monads, but form distinct genera, as Microglena, &c.

As the Infusoria of this genus are chiefly curious on account of their extreme minuteness, and in no other respect, the species are not deemed of sufficient interest to be expatiated upon at any great length; their leading characters and size, therefore, are only given. And we may remark, generally, that most of them are inhabitants of water in which any organic matter is undergoing decomposition.

The Monads are arranged under two divisions, according to their external forms. The first division contains all those which are of a globular or oval shape (globular Monads), and the second those of a lengthened form, more than twice as long as broad (elongated Monads).

A.—Globular Monads.

(*a*). *True Globular or Sphero-Monad—colourless or whitish.*

1. Monas *crepusculum.* *The twilight Monad.*—The animalcules of this species are the smallest of all living creatures. They are of a spheroidal form and hyaline,

although, when seen in masses with the naked eye, they appear of a whitish hue. They are active and carnivorous, feeding on animal as well as fungoid substances. They are found in water wherein animal matter is held in solution, but as the decomposition of the animal matter proceeds, the animalcules die, and their bodies may be seen rising to the surface of the water, and forming a thicka nd colourless gelatinous stratum. *Group* 1 in the engraving is magnified 800 diameters. They rarely attain to 1-12,000 of an inch in diameter, and never exceed it.

2. MONAS *termo* (M). *The end or limit Monad,* so named from its having been supposed to be the limit of animal organization. Active, herbiverous, found in stagnant water, and increase rapidly where there is an abundance of vegetable matter undergoing decomposition. Size 1-600th, although some are not one half or even a third of that measurement.

3. MONAS *guttula* (M). *The drop Monad.*—Inactive. May be preserved by drying. Twelve stomach-cells may be seen by the aid of indigo or carmine. Surface appears granulated. Found in vessels of water containing plants or flowers. Size 1-2300th, or less.

4. MONAS *vivipara. The viviparous Monad.*—Inactive. Found in stagnant water (**), coloured. Size 1-620th, or less.

5. MONAS *grandis. The great Monad* is of a greenish colour except near the mouth. Proboscis short, 1-3rd or 1-4th the length of the body. It is sluggish. Found in marsh water, very rare. Size 1-430th.

6. MONAS *bicolor. The Two-coloured Monad.*—Colourless, excepting one or two green spots within it, attenuated anteriorly. Motion vacillating. Size 1-1440th.

7. MONAS *ochracea.* *The ochre-coloured Monas.*—Yellow-ochre colour. Found in water-courses. Size 1-6000th at most.

8. MONAS *erubescens.* *The pale-red Monad.*—Rose-coloured, and with a slow but continual motion. Found in salt water. Size 1-1728th.

9. MONAS *vinosa.* *The wine Monad.*—Colour of red wine. Tremulous motion. Rejects coloured food. Found in vegetable infusions. Size from 1-12000th to 1-6000th.

(*b*). *Oval or Egg-shaped Monads—all colourless.*

10. MONAS *kolpoda.* *The mamma-shaped Monad.*—Vacillating motion. Discovered in water in the silver mines of Siberia. Size 1-7200th.

11. MONAS *enchelis.* *The flask-shaped Monad.*—Continuous slow motion. Found in marsh water. Size 1-1200th to 1-960th.

12. MONAS *umbra.* *The shadow Monad.*—Rapid motion. Found among fresh conferva. Size 1-2400th.

13. MONAS *hyalina.* *The diaphanous Monad.*—Active, and seems to leap or jump. Found in stale water in glass vessels. Size 1-6000th to 1-2880th.

14. MONAS *gliscens.* *The gliding Monad.* — Gliding motion. Found in watery infusions of the stinging nettle. Size 1-4500th.

15. MONAS *ovalis.* *The little Egg-shaped Monad.*—Tremulous motion. Found in water of the Anodonta Molusca. Size 1-9600th.

16. MONAS *mica.* *The glittering Monad.* Rotatory and vacillating motion. Inhabits clear fresh water. Size 1-1440th to 1-1200th.

17. MONAS *punctum.* *The point egg-shaped Monad.*—Revolves on the longitudinal axis of its body. (See engraving, *group* 2; the lower figure exhibits one undergoing longitudinal division.) Found in water with tannin. Size 1-1150th.

B.—ELONGATED MONADS.

(*a*). *True Elongated Monads.*

18. MONAS *cylindrica.* *The cylinder-shaped Monad.*—Solitary, colourless, revolves as it progresses. Found in salt water. Size 1-1150th.

19. MONAS *Okenii.* *Okens elongated Monad.*—Red, revolving, vibratory motion, social. Found in running water. Size 1-2300th.

(*b*). *Conical.*

20. MONAS *deses.* *The lazy Monad.*—Green, solitary. Found in water from hills. Size 1-1200th.

21. MONAS *socialis.* *The social Monad.* Colourless, social. Found in water-butts. Size 1-700th.

(*c*). *Top-shaped.*

22. MONAS *flavicans.* *The yellow Monad.* — Social, gliding motion. Found in ditch-water. Size 1-1720th.

(*d*). *Spindle-shaped* (*), *colourless.*

23. MONAS *simplex.* *The simple spindle Monad.*—Gliding and rotatory motion. Found in water of the Nile, and at Berlin. Size 1-1720th.

24. MONAS *inanis.* *The empty spindle Monad.*—Vacillating motion. Found in stagnant and foul water. Size 1-3600th.

25. MONAS *scintillans.* *The sparkling spindle Monad.*—Very active. Vacillating motion. Found amongst fresh water conferva, &c. Size 1-6000th to 1-4600th.

26. MONAS *Dumalii.*—These animalcules, discovered by M. Joly, are of a deep red colour. They occur in vast numbers in the salt marshes of the Mediterranean, and give to those waters a deep blood colour. They are eaten by a small Entomostracean, the Artemia salina.—(*Ann. N. H.* xxxvii. 317.)

Genus II. UVELLA. *The grape Monads.*—The species of this genus are very well characterised by their aggregating together occasionally, so as to form a grape or mulberry-like mass, and by their generally possessing two (?) hair-like proboscides at the mouth. Like the Monas, they are deficient of the projecting lips, visual organ, and tail, and have the mouth situated at the anterior extremity. They progress also in the direction of the longest axis of their body, and are endowed with the capability of complete self-division. There are six species—two green, and the remainder colourless.

27. UVELLA *viriscens. The yellowish-green Uvella* (*Volvox uva,* M.)—Body ovate, and of the colour that gives rise to its specific name. Found amongst conferva and lemna. Size 1-2000th; diameter of cluster 1-280th.

28. UVELLA *chamaemorum. The colourless bramble-berry Uvella.*—Smaller than the preceding one. Found in water-butts. Size 1-2880th; diameter of cluster 1-570th.

29. UVELLA *uva. The grape Uvella.*—Has indistinct ventricles, and is very small. Found in stagnant water. Size 1-4800th; diameter of cluster 1-960th.

30. UVELLA *atomus. The atom Uvella* (*Monas atomus, M. lens et Volvox socialis,* M.)—Voracious, with large ventricles. Size 1-6900th to 1-3406th; diameter of cluster 1-1150th.

31 Uvella *glaucoma*. *The glaucous Uvella* (*Volvox socialis*, M.)—Form oval, but inclining to conical, with the posterior extremity attenuated as it advances in age. Hyaline, with large ventricles, and evidently two filiform proboscides. In 1831, Ehrenberg first observed a vibration at its anterior part, and its reception of coloured food. In 1835, he discovered within the body of this minute creature some green Monads which it had eaten, and by which it was proved to subsist by prey. When fed on indigo, as many as twelve stomachs were filled, and it has been sometimes seen to void little blue particles, which seemed like undigested matter, from its mouth. With a power of 800 diameters a great number of small colourless granules, having the appearance and form of eggs, may be discerned, lying between the nutritive sacs. It increases both by a transverse and longitudinal section. Engraving, *group* 3, represents a cluster of these creatures; *figures* 4 and 5, separate young ones; and 6, an old one. They are magnified about 350 diameters. The individuals, when full grown, are elongated, and their ova may be perceived with 800 linear. Ehrenberg has seen them prey on the green Chlamidomonas. Found in water-butts. Size 1-2300th to 1-2350th; diameter of cluster 1-430th.

32. Uvella *bodo*. *The green Uvella.*—Fore part of the body rounded, attenuated posteriorly. It is of a beautiful green colour; found in stagnant water. Size 1-4030th to 1-3450th; diameter of cluster 1-2350th.

Genus III. Polytoma. *The Partile Monads.*—This genus is characterized by its possessing a truncated mouth, furnished with a double flagelliform or whip-shaped proboscis, situated, as with Monas and Uvella, at the

anterior extremity of the body. It is wanting of the eye and tail. As the young increase in size, the parent body assumes a decussated or wrinkled appearance, like a mulberry, thus giving signs of its approaching self-division into *many sections* (as the name Polytoma denotes), or numerous individuals. Its internal organization bears the usual evidences of the Polygastric nutritive system. Its only organ of locomotion is the double proboscis just mentioned. A large contractile vesicle may sometimes be observed within the creature, which Ehrenberg conceives to belong to the male propagative apparatus. This animalcule will not imbibe colouring matter. It increases by a spontaneous self-division of its body, both transversely and longitudinally, thus dissolving, as it were, its berry-like cluster into many individuals. It was known to Müller and Wrisberg. One species has been recognized.

33. POLYTOMA *uvella.* *The grape Polytoma* (*Monas uva*, M.)—This creature is colourless, and has an oval or oblong form, equally obtuse at both extremities. It is often abundant in water, where animal matters are in solution, upon which it appears to be nourished. It is generally in company with species of Vibrio and Spirillum, and sometimes with Uvella uva and Uvella atomus, in water-butts.

Figures 8 and 9 represent two individuals; figure 10, another about to divide longitudinally; a cluster of eight is seen as *fig.* 7; and a matured one on the point of separating at *figure* 11. *Figure* 9 is magnified 800 diameters, shewing the double proboscis very distinctly; and its body seems enveloped in an outer tunic (probably induced by the peculiar contraction), which disappears when the

division is completed. Size about 1-2000th to 1-900th; diameter of clusters, 1-380th.

Genus IV. Microglena. *The eye Monad.*—This genus is essentially characterized by the species all having a minute red eye-like speck, situated within the creature, at the anterior part of the body. In other respects they resemble true Monads, by being deficient of the projecting lips and tail, and by their swimming in the direction of the long axis of the body. They possess a very delicate flagelliform proboscis, of simple structure. They multiply by a complete self-division of the body. Two species only are known, the one yellow, and the other green.

We now approach to a description of living creatures, whose organization, on account of their magnitude, is rendered more apparent to us. The red eye-like speck, the distinguishing feature of this genus, may be assumed to be a rudimentary visual organ, notwithstanding nervous ganglia subservient to it have not been perceived, as with the still larger Infusoria, the Euglena, Rotatoria, and single-eyed genus of Entomostraceans, the Daphnia. This organ, together with the proboscis, its locomotive and purveying instrument, the beautiful green homogenous granules seen in M. monadina, which, by their shape and situation in the body, leave no reasonable doubt of their being ova, and the grey rolled band-like seminal gland, demonstrate that these living atoms are endowed with systems of organization (a sensitive one too) as conformable to their particular uses, and as well adapted to supply the wants of the creatures, as those even in the largest fish. Still are we left to conjecture with respect to their possessing a vascular system or not: it has never been perceived, and

we can only argue, as we have done already, that if there be one, the vessels in beings so minute must necessarily be of such delicate structure, that we may not as yet have found out the means of making ourselves acquainted with them.

34. MICROGLENA *punctifera* (*Enchelys punctifera* M.), The *yellow Microglena.*—Yellowish colour, form oval, or almost conical, and terminated acutely at the posterior extremity. Red eye, with a blackish central spot, as if a secondary visual appendage. Found among slimy water-plants. Size 1-620th.

35. MICROGLENA *monadina. The green Microglena.*—Beautiful green-colour; form ovate, rounded equally at both extremities; a distinct single red eye, proboscis nearly as long as its body, a vibrating rotatory motion on its long axis. *Figures* 12, 13, and 14, represent three animalcules magnified, the first 800 diameters, exhibiting all the internal organization noted above. Found among slimy water-plants (Hampstead and Finchley). Size 1-2300th to 1-720th.

Genus V. PHACELOMONAS. *The fan Monad.*—The distinguishing characters of this genus are the numerous proboscides placed round the mouth of the creature, as it were a wreath of cilia, composed of from 8 to 10. In other respects it resembles the Microglena: it has the small red eye, the truncated mouth at the anterior extremity, and is deficient of the tail. It swims in the direction of the longitudinal axis, and its self-division is either simple and complete, or it never d ivides. Many stomach-cells have been observed within the body, but they have not been seen to admit artificial coloured food. This genus has not been illustrated by Ehrenberg.

36. PHACELOMONAS *pulvisculus* (*Monas pulvisculus,* M.) *The green Phacelomonas.*—This creature is of an oblong or slightly conical form, attenuated posteriorly, and of a beautiful green colour. Just previous to self-dividing its body becomes cylindrical, and then contracts at the centre; but when dying it changes to a globular shape. In swimming, it turns quickly upon its longitudinal axis, without any vibration. This animalcule demonstrates the fact, that proboscides and cilii are organs not materially different from each other. Found in green puddles. Size 1-1152nd.

Genus VI. GLENOMORUM. *The bride Monad.*—This genus is especially indicated by its possessing a single red eye, a truncated mouth, and double filiform proboscides; by its being destitute of a tail, by the individuals moving on the long axis of the body, by their self-dividing simply and completely into two, or not dividing at all; and by their *volnntarily* clustering, as occasion may require, so as to give themselves the resemblance of a bunch of grapes.

In this enumeration of the characters belonging to this genus, we are presented with an excellent illustration of the table (and one that exceedingly well explains its use), under which all the genera of the family Monadina are arranged, so as to exemplify in what respects they are alike, and in what they differ from each other. (For example, see Table, p. 88.) The Glenomorum closely resembles the Uvella, but differs from them by the superaddition of the red eye; it differs from Monas and Microglena through occasionally aggregating; from Chilomonas, in being deficient of the projecting lips; from Bodo, in not having the tail; from Phacelomonas, by the double proboscis; from Doxococcus, by swimming, instead of rolling over or revolving

in the water; and from Polytoma, by never appearing in clusters whilst undergoing self-division.

37. Glenomorum *tingens. The green Glenomorum.*—This creature has a fusiform body, which is of a beautiful green colour, and three or four times longer than it is broad. Its double proboscis is exceedingly delicate, and about half the length of its body; within it may be seen some small whitish vesicles, the stomach-cells, and also some minute granules, which give rise to the green colour, and may be considered as ova. About the centre of the body is a large transparent colourless organ, which Ehrenberg supposes to be of a male sexual nature. The beautiful red eye is fixed internally, about one-third from the anterior extremity of the body. These animalcules constitute a great portion of the green matter commonly seen on stagnant water, and discovered by Priestley. They appear to be nearly allied to the Cercaria viridis, differing from them only in magnitude, and in the unalterable form of their bodies. *Figure* 15 represents two clusters; 16, single ones, magnified 250 times; 17, another magnified about 450 diameters. Found plentiful at Hampstead. Size 1-3600th to 1-1700th.

Genus VII. Doxococcus. *The revolving Monad.*—The individuals of this genus differ from those of the whole family Monadina by the singularity of their motion, which may be defined to be neither that of swimming nor of rotation, but a sort of rolling over and over. In other particulars they are like the Monads. They have the same unvarying form, and are destitute of the eye, projecting lips, and tail. Their self-division is simple and complete, or they do not divide at all, in which case they

increase by ova. These characters are sufficient to distinguish them from all other Infusoria, and to justify their being placed in the family Monadina. Four species are known.

38. Doxococcus *globulus* (*Volvox globulus,* M.) *The globular Doxococcus.*—Form subglobose or ovate; transparent as water; easily known by its tedious rolling motion; mouth not discerned. Found in salt water. Size 1-860th.

39. Doxococcus *ruber. The red Doxococcus.*—Form globular; colour brick red, opaque. Ehrenberg appears to doubt whether this animalcule holds its proper situation here, or whether it should be placed with the genus Trachelomonas, though its motion is very peculiar; and he has not been able to satisfy himself of the existence of a lorica, or shell, enveloping the creature. *Group* 18 represents three magnified individuals. Found amongst conferva, &c. Size 1-1720th.

40. Doxococcus *pulvisculus. The Green Doxococcus.*—Form perfectly (?) globular; colour green, but opaque. Found amongst conferva. Size not exceeding 1-1280th.

41. Doxococcus *inequalis. The irregular-shaped Doxococcus.* — Form irregularly globular; transparent, and covered with green spots. Found amongst conferva. Size 1-2400th.

Genus VIII. Chilomonas. *The lip-Monads* constitute but a small genus. They are characterized by the oblique position of the mouth, with respect to the longitudinal axis of their bodies, which occasions an overhanging or projecting form above the mouth, of a lip-like appearance. All the species propel themselves in the direction of the long axis of the body. Their form is invariable, and they

are devoid both of the eye and tail. Whether the projecting lip is furnished with cilia, or with a double flagelliform proboscis, Ehrenberg has not satisfactorily determined. He states, however, that two proboscides are to be distinctly seen on the C. paramecium, whilst on the C. destruens there are a number of cilia, which are not quite so apparent. Their self-division is either simple and complete, or they do not divide.

42. CHILOMONAS *volvox.* *The rolling Chilomonas.*—Form ovate; attenuated and truncated anteriorly; transparent and colourless; projecting lip long; they will feed on indigo. Found in stagnant water. Size 1-1440th.

43. CHILOMONAS *paramecium.* *The triangular Chilomonas.*—Form oblong, keeled longitudinally, colour resembling dirty water. This animalcule is easily distinguished by its shape and peculiar lip-like process. With a power of about 240, numerous digestive cells are visible; and with 380, the two proboscides, which are half the length of the body, may be perceived. It moves in the direction of its long axis, but in a fluctuating or wavering manner. It sometimes clusters. *Group* 19 represents two of these creatures magnified 380 times, and six others less magnified. Three are clustered. Found in water wherein wheaten bread has been steeped. Size 1-1020th.

44. CHILOMONAS *destruens.* *The destructive Chilomonas.*—Form oblong, but variable, on account of its softness. Faint yellow, nearly colourless. Found in salt and fresh water, and in the bodies of dead Rotatoria (Anurœa foliacea and Monocerca rattus). Size 1-860th.

Genus IX. BODO. *The tailed Monads.*—The caudal appendage at the posterior extremity of these animalcules is a

decisive character of the genus Bodo. In other respects, the species may be described as being eyeless, and having the terminal mouth furnished with a single (?) filiform proboscis, and as undergoing self-division, simply and completely into two, or not dividing at all. These creatures never constitute true or perfect clusters, like some of the family Monadina, although, like the Uvella they occasionally enter into social compact. In the species B. grandis, several digestive sacs have been observed, and (as also in the B. intestinalis) a simple (perhaps double?) proboscis, its organ of locomotion. The Bodo didymus has been known to divide transversely. Only one of the species of this genus having fallen under my own investigation, the account of them here given is entirely abstracted from *Die Infusionsthierchen.*

45. Bodo *intestinalis. The intestine Bodo.*—Form almost conical; tail of equal length with the body; transparent and colourless. Found in several living animals, such as frogs, toads &c. In the grey and edible frogs, amongst the watery mucus of the alimentary canal, Ehrenberg has observed great numbers of these creatures, and remarks that the Cercaria gyrinus of Müller (a different animalcule) might pass as a representation of this species, and that it was confounded by its discoverer with the spermatic animalcules. *Group* 20 represents them magnified about 300 diameters. Size 1-1720th.

46. Bodo *ranarum. The frog Bodo.*—Body turgid, ventricles indistinct. Found in live frogs, with the preceeding species, and with the Bursaria ranarum. Size 1-1440th.

47. Bodo *viridis. The green Bodo.*—Form nearly glo-

bular; tail very short; colour green. Found amongst conferva. Size 1-2400th.

48. Bodo *socialis.* (*Monas lens,* M.) *The social Bodo.*—Form ovate or subglobose; tail often longer than the body; transparent and colourless. Clusters into a mulberry shape. The single forms are sometimes observed hopping. Very common in stagnant water. Size 1-2970th.

49. Bodo *vorticellaris. The bell-shaped Bodo.*—Body three times as long as it is broad; tail very short. Found in fresh water. Size 1-1200th.

50. Bodo *didymus. The double-tailed Bodo.*—Body generally constricted about midway, tail short. Size 1-9600th.

51. Bodo *saltans. The leaping Bodo.*—Very small; body with ample ventricles; tail short. This creature, most probably from its small size, has been mistaken for Müller's Monas termo, but its brisk leaping movement will sufficiently distinguish the one from the other. Size 1-12000th.

52. Bodo *grandis. The great Bodo.*—This creature has an oblong form, ample ventricles, and rigid setaceous tail, affixed to the abdomen. Found in stagnant water. Size 1-864th.

53. Bodo *oystea. The oyster Bodo.*—Has a globular body; the anterior three-fourths occupied with vescicles, the rest hyaline; length of tail four times the diameter of body. This active creature I discovered in the liquor of an oyster, swimming freely among the ova (Sept. 1834). Diameter 1-2000th.

Family II.—CRYPTOMONADINA.

The family Cryptomonadina exhibits all the characteristics (and no certain or definite ones of any other family) of the Monadina, together with a distinct gelatinous, membraneous, or hard induvium, or shell-like substance, termed a lorica, in which they are more or less enclosed. Considering them as a family, their organization has been determined as completely as that of the Monadina, or even the larger Polygastrica; although, in all probability, something more is yet to be learnt of the species individually. The lorica, or integument covering these creatures, is of different forms; sometimes it is of the form of an open shield (*scutellum*), at others of a closed box or a pitcher (*urceolus*). Locomotive organs are clearly perceptible in all the genera, excepting, perhaps, the genus Lagenella, and even with this Dr. Warwick is of opinion that he has discerned them. They consist of two delicate, filiform, and generally retractile processes, issuing from the margin of the mouth; they are capable of being put into very powerful rotatory motion. We shall designate them, as with the Monads, proboscides. The nutritive apparatus of these creatures has not yet been demonstrated by the application of coloured artificial food; but with six or seven species (nearly one-half the family) internal cells have been discovered. In two genera, a sensitive system may be presumed to exist, from a coloured spot or eye-like appearance being present in the interior of the fore part of the body. From the position of this organ of vision, the dorsal line may be readily conceived, so as to indicate a

right and left side of the creature. The individuals either self-divide simply and completely, or they do not divide at all. "It is possible," says Ehrenberg, "that the fossil animalcules discovered in the flint of chalk and porphyritic formations, and named by me Pyxidicula (see *plate* xii. upper figures), belong to the genus Trachelomonas." The genera hold the following relations :—

Eye absent	Lorica obtuse and smooth	Form short, self-division longitudinal or wanting	Cryptomonas.
		Form long and tortuous Self-division transverse	Ophidomonas.
	Lorica pointed anteriorly	....	Prorocentrum.
Eye present	Lorica with a neck and narrow orifice	....	Lagenella.
	Lorica with the orifice without a neck	Lorica an open shield (*Scutellum*)	Cryptoglena.
		Lorica a closed box or pitcher (*Urceolus*)	Trachelomonas.

The species of this family are readily recognized by the stiffness or inflexibility they display while swimming, or when brought into contact with other bodies. The lorica of the Prorocentrum and Lagenella is at once perceived to be a distinct covering. When any doubt, however, exists upon this point, a slight degree of pressure in the aquatic live-box, or between two slips of polished glass, will easily determine it. The lorica of the Trachelomonas is of a siliceous quality, and indestructible by fire.

Genus X. Cryptomonas. *The loricated Monads.*— This genus is essentially characterized (see the Table) by the species being destitute of the visual organ, and having a lorica obtuse, or not attenuated, towards the anterior. Body short, but not filiform; self-division, if any, longitudinal.

54. CRYPTOMONAS *curvata.* *The curved Cryptomonas.*—Form compressed, slightly bent like the letter S, and twice as long as it is broad; colour green. Found amongst conferva. Size 1-570th.

55. CRYPTOMONAS *ovata* (*Enchelys viridis,* M.) *The egg-shaped Cryptomonas.*—Form depressed, oval, and twice as long as broad; colour green. Motion slow, vacillating, and rotating on the longitudinal axis; but when obstructed, the creature is seen to leap. Lorica paper-like, not hard, and the numerous internal and transparent vesicles perceived amongst the green ova are the alimentary sacs. In the middle of the creature there are two or three egg-shaped bodies, supposed to be seminal glands, and at the posterior part a single variable vesicle of a sexual nature; self-division not observed. *Figures* 21 and 22 represent two full grown creatures (side and back view), magnified 300 diameters; and *figure* 23, a young one. Found amongst conferva. Size 1-570th.

56. CRYPTOMONAS *erosa.* *The marginated Cryptomonas.*—Body depressed, oval; colour green, anterior part hyaline. Found in clean water, among conferva. Size 1-960th.

57. CRYPTOMONAS *cylindrica* (*Enchelys viridis,* M.) *The cylinder-shaped Cryptomonas.*—Body elongated, subcylindrical, three times as long as broad. Found amongst conferva. Size almost 1-1000th.

58. CRYPTOMONAS (?) *glauca.* *The blueish Cryptomonas.*—Form oval, twice as long as broad; anterior portion truncated, double flagelliform proboscis. Body turgid, and of a blueish-green colour Found with the Chlamidomonas pulvisculus. Size 1-864th.

59. CRYPTOMONAS (?) *fusca.* *The brown Cryptomonas.*—Oval, turgid, and of a brown-colour. Found amongst conferva. Size 1-1500th.

60. CRYPTOMONAS *lenticularis.* *The lens-shaped Cryptomonas* —Form orbicular, resembling a lens; colour green; lorica thick. Size 1-1720th.

Genus XI. OPHIDOMONAS. *The serpent Monad.*—The distinguishing characters of this genus are its filiform body, deficient of the eye, its smooth and obtuse lorica, and its transverse but complete mode of self-dividing. It was discovered by Ehrenberg in September, 1836. It is furnished with a filiform proboscis, as its organ of locomotion, which, together with the tubular lorica, and the numerous digestive sacs, form the whole of the organization that has hitherto been demonstrated. Its extremely small transverse diameter is the great impediment to a better acquaintance with this creature. Whether its brown-colour is derived or not from the ova within it has not been determined, nor has it been drawn.

61. OPHIDOMONAS *Jenensis.* *The Jena Ophidomonas.* —Form very thin, curved spirally, and equally obtuse at both extremities; colour olive-brown; motion brisk. Found only at Jena, in well water. Size 1-570th.

Genus XII. PROROCENTRUM. The *pointed shell Monad.* —The animalcules of this genus are destitute of the eye, and have a smooth lorica, resembling a little box (*urceolus*), pointed at the anterior extremity. They have a filiform proboscis, for the uses previously described, and numerous large digestive cells in the interior of the body. Self-division has not been observed. "It is worthy of remark," says Dr. Ehrenberg, "that the only species of this genus with

which we are acquainted belongs to the luminous creatures of the sea, which, perhaps from some peculiar organic relation or condition, yet unknown to us, are instrumental in producing that curious and certainly vital phenomenon usual termed a phosphorescent sea." It may be further noticed, that all the luminous Infusoria of the sea, hitherto discovered, are characterized as being of the same yellowish waxy colour as the species of this genus; and it is probable that this condition is immediately connected with the interesting phenomenon in question.

62. PROROCENTRUM *micans. The glistening Prorocentrum.*—Form oval and compressed, attenuated at the posterior part, but dilated and pointed anteriorly; colour of yellow-wax. Found in sea water. *Figures* 24 and 25 exhibit two animalcules magnified 300 diameters; the first is a side view, the latter a back view. The cilia proboscis in *figure* 24 indicates the position of the mouth. Size 1-430th.

Genus XIII. LAGENELLA. *The flask-shaped Monad* is distinguished from the other loricated Monads by its closed shell extended anteriorly, so as to give it a neck-shaped appearance, like that of a bottle or flask. This shell or lorica is perfectly distinct, and as clear as crystal. The only part of the organization of the creature at present known is the eye, or bright red speck, which is always to be seen in this genus, and the green granules within the body of the animalcule, which Dr. Ehrenberg supposes to be ova.

63. LAGENELLA *euchlora. The beautiful green Lagenella.*—Form oval, neck short and truncated; lorica crystalline; colour of the body or eggs green. *Figures* 26,

27, and 28, are representations of this creature magnified. Found amongst conferva. Size 1-1200th.

Genus XIV. Cryptoglena. *The loricated Monads, with an eye.*—This genus is distinctly characterized by the species having an open lorica, of the form of a shield (*scutellum*), but folded or rolled inwardly at the sides, and without the projecting neck. The eye is perfectly evident, and the small digestive cells appear to be covered with green egg-like granules. In the species C. conica, traces are seen in the centre of the body of a male generative structure, in the form of two oval glandular substances, of a greyish colour; in this species also a double filiform proboscis is seen. Self-division has not been observed in any of the genera, which are all of a green colour.

64. Cryptoglena *conica. The cone-shaped Cryptoglena.*—Form conical, dilated and truncated at the anterior, and furnished with two filiform proboscides, half the length of the body; they are acutely attenuated towards the posterior portion of the body. Colour a blueish-green. *Group* 29 is a magnified representation of three creatures. They are found in great numbers in butts of river water, in company with the Cryptomonas glauca, from which they are readily distinguished by their form, larger size, and red eye. They move briskly in the direction of the longitudinal axis of their bodies, but when obstructed, they spring or leap out of their course. Size 1-1100th.

65. Cryptoglena *pigra. The slothful Cryptoglena.*—Form oval, approaching to globular, and emarginate at the anterior; colour a beautiful green; movement slow. Found in water, when covered with ice. Size 1-3000th.

66. Cryptoglena *cœrulescens. The cerulian Cryp-*

toglena.—Form depressed, elliptical and emarginate anteriorly; colour blueish-green; motion quick. Found amongst conferva. Size 1-6000th.

Genus XV. Trachelomonas. *The Monad with the trunk.* — This genus comprehends those loricated animalcules of the family Cryptomonadina which are possessed of the visual organ, and of a closed lorica, of a box-like shape, elongated or spherical, but without the projecting neck. They are furnished with a long single filiform proboscis or seta, for the purposes heretofore described, and in two species, T. nigricans, and T. volvocina, very minute transparent vesicles have been discerned, which are most probably their digestive sacs. In the species T. cylindrica egg-like granules are visible. Two species are green, and one blackish-brown. It is most probable that those highly interesting animalcules which enter so abundantly into the silicified substances in certain chalk formations belong to this genus.

67. Trachelomonas *nigricans.* *The blackish Trachelomonas.*—Form oval, approaching to globular; colour rarely green, mostly of a reddish or blackish-brown. Eye brown. Size 1-1700th.

68. Trachelomonas *volvocina.* The *revolving Trachelomonas.*—Form spherical; colour mostly green, sometimes of a brownish hue, but easily distinguished by a red ring on the circumference of the body; vesicles may be observed within it, which are most probably the digestive sacs, between which a very fine granulated substance is situated, which occasions the colour of the body. It is furnished with a delicate flagelliform proboscis for purveying and locomotion. The red circle, so remarkable a feature

in this species, always appears to abide in the same horizontal position, how quickly soever the creature may be revolving on its longitudinal axis. *Figure* 30 represents this creature with its proboscis extended; *figure* 31, another with it retracted; *figure* 32 is a very young specimen; and 33, a full grown one, that has been pressed between two plates of glass, so as to exhibit the lorica broken without destroying any other part, except the red circle above noticed. Found amongst conferva. Size 1-860th.

69. TRACHELOMONAS *cylindrica. The cylindrical Trachelomonas.*—Form oblong, approaching to cylindrical; proboscis almost as long as the body. Colour a beautiful green; eye red; ring purple. Size 1-1000th.

Family III.—VOLVOCINA.

This family derives its name from the *rolling motion* with which the extraordinary creatures belonging to it make their way through their natural element—the water. The mode in which they self-divide, whilst pent up within their loricated vestment, is a curious characteristic of the family, and such as would almost warrant the supposition that they hold some very near relationship to those remarkable creatures termed Zoophites. They resemble the Monads in most particulars relating to their organization. The body is unvarying and destitute of appendages? They have several digestive sacs, but no true alimentary canal. Whilst propagation by self-division is proceeding, and the young are increasing in size, the surrounding induvium, which is a distinct lorica, is observed to expand in a corresponding degree, but continues entire until they have come to maturity, when it is seen to burst, and set the numerous occupants at liberty. The animalcules thus set free multiply in the same manner, and also by means of ova—in which case the expansive property of the lorica comes equally into operation.

All the genera (excepting, perhaps, the Gyges), are provided with organs of locomotion, which consist, as with the Monads and Cryptomonads, of a single or double flagelliform proboscis, of very delicate texture; and hence it is that, when they are in clusters, the entire heap appears to be ciliated, or beset with hairs. Transparent digestive cells are visible in the Volvox globator and Gonium pectorale,

but in most of the species the green ova hide them from our sight. The propagative apparatus is evident in all the genera, with the exception of the Uroglena, under the form of ova grains, one or two round glands, and a contractile bladder.

The family is disposed into ten genera: five are furnished with the visual organ, situated at the anterior part of the body, and five are not. In the former, a sensitive system is consequently presumed.

The following is an analysis of the family, and arrangement of the genera:—

- Eye absent.
  - Tail absent
    - Lorica single
      - Lorica box-like
        - vibrating proboscis absent ... Gyges.
        - vibrating proboscis present ... Pandorina.
      - clusters tabulated or in plates .... Gonium.
    - Lorica double .... Syncrypta.
  - Tail present .... Synura.
- Eye present.
  - Self-division both equal and perfect (no internal globes)
    - tail present .... Uroglena.
    - tail absent ...
      - proboscis single ... Eudorina.
      - proboscis double ... Chlamidomonas.
  - Self-division unequal (forming internal globes)
    - proboscis single .... Sphaerosira.
    - proboscis double .... Volvox.

Genus XVI. Gyges. *The ring Animalcule* is characterized by the species being deficient of the eye, tail, and vibrating filiform proboscis. The lorica is of a simple box-like form (*urceolus*). We know but little of their organization, as not even the nutritive apparatus has been observed; and were it not that some slight spontaneous motion of the body is perceptible, when it is surrounded with a coloured fluid, it would seem that they were wanting in all the certain characteristics of an animal. Two species

are mentioned by Ehrenberg, both of a green-colour, and enclosed in a transparent lorica.

70. Gyges *granulum* (*Volvox granulum*, M.) *The grain Gyges.*—Form oval, approaching to globular. Body contains a heap of granules within it, of a darkish-green colour. Found amongst lemna and conferva. A magnified representation is given at *fig.* 34. Size 1-1150th.

71. Gyges *bipartitus.* *The bipartite Gyges.*—This species has a body of a crystalline gelatinous substance, and of nearly a spherical form; the superficies being colourless, and its contents of a yellowish-green. Its body is sometimes divided into two, and at others it is a simple sphere. The internal mass is composed of numerous homogenous granules, which, if the creature be an animal, may be considered as the ova. Found amongst conferva. Size 1-480th.

72. Gyges *sanguineus.* *The blood-coloured Gyges.*—Body oval, colour red, inclining to crimson, surrounded by a broad colourless margin. This is a new species, discovered by Mr. Shuttleworth in the red snow, which fell at the Grimsel, in August, 1839; its motion is lively. In plate xii., *group* 527 shews several highly magnified. Found with Astasia nivalis and Monas gliscens, among the globules of Protococcus nivalis. See *Ed. Phil. Jour.* v., xxix. Length, 1-1200 to 1-300th.

Genus XVII. Pandorina. *The berry-like globe Animalcules.*—The characteristics of this genus are its being destitute of the eye and tail, but provided with the box-like lorica, of a globular shape, and with the filiform proboscis. During the process of self-division, the internal development gives the creature the appearance of a mulberry. A

simple proboscis is present in all the species (at least the European) as the organ of locomotion &c., and transparent vesicles, seemingly the nutritive apparatus, may be observed. There are two species only, one green, and the other colourless; the latter, however, is a doubtful Pandorina.

73. *Pandorina morum* (*Volvox morum*, M.) *The green Pandorina.*—Body simple, or multipartite, enclosed within a simple lorica. Colour green; proboscis twice as long as the body. *Figure* 37 represents a cluster; 36, a single animalcule; and 35, one in which self-division has just commenced. Found in water with lemna and conferva. Size of individual, 1-1150th; ditto cluster, 1-120th. Individuals broken from the cluster by Ehrenberg have not been above one-third the former measurement.

74. Pandorina? *hyaline*. *The crystalline Pandorina.*—Form globular. Found in water of the Nile with conferva. Size 1-5760.

Genus XVIII. Gonium. *The tablet Animalcules.*—The members of this genus are especially characterized by being deficient both of eye and tail, but having a simple lorica, and developing themselves in the process of self-division in clusters, whose form is that of a regular four-cornered tablet or plate. The lorica of each individual (as is noticed after separation) is nearly round, and resembling a mantle (*lacerna*), which the creature is empowered to cast off, and form anew. In one of the species (G. pectorale) two filiform and vibratory proboscides are placed at the mouth, as organs of locomotion, &c.; in the other species, these have not been observed. Vesicles are seen within G. pectorale, notwithstanding the creature abstains from coloured food; and a red speck (produced probably by

inflected light) at the base of the proboscides has been perceived by Ehrenberg, which he conceives to be the mouth.

75. GONIUM *pectorale* (M). *The breast-plate Gonium.* —The form of this animalcule, or more correctly, cluster of animalcules, is shewn at *figs.* 38, 40, and 41. It consists of sixteen spherical bodies, enclosed within a transparent lorica or shell, and disposed regularly in a quadrangular form, like the jewels in the breast-plate of the Jewish High Priest. They are all arranged in the same plane. The four centre ones are generally larger than those which surround them, and the diameters of the three smaller balls are about equal to the two larger centre ones to which they are attached; the external corners are consequently vacant. As these animalcules swim and revolve in the water, they occasionally present a side view to the observer, when the circumference of the larger central globules may be seen projecting beyond the others. Sometimes the cluster appears irregular; this happens when the larger animalcules have arrived at maturity, and some of them are separated from the cluster. When they are all of equal diameters, the group divides across the middle, both vertically and horizontally, and separates into four clusters, each consisting of four animalcules. As soon as a cluster has separated, the respective animalcules increase in size, and in a short time their surfaces appear decussated, and they severally begin to form into regular clusters, like the original one to which they belonged. They are of a beautiful transparent green colour, and in swimming, the globules often appear of an ellipsoidal figure (see *fig.* 40); their forms, when viewed under the microscope in the usual way, are so simple, and so different

from animated beings visible to ordinary vision, that it would be difficult to bring our reason to admit of their vitality, were not their spontaneous motion clearly ascertained; but when examined under a high magnifying power, with proper illumination and management, their structure becomes apparent. *Figure* 39 shews a single free animalcule, with its two proboscides, and *figure* 42 a highly magnified view of another, invested within the lorica. In this figure is seen the disposition of the six cords or tubes which connect it to the surrounding ones; also numerous corpuscles within the body. A combination of sixteen animalcules (never more, but sometimes less) generally forms the square tablet or plate.

In order to observe the structure of this highly curious and beautiful creature, considerable adroitness is necessary in the management of the microscope, while a little indigo, conveyed into the water with the point of a camel's hair pencil, will be required to see the whorls and currents set in motion around it. It is almost incredible what power, comparatively speaking, these minute beings possess, notwithstanding the speck they appear to occupy in the scale of creation. The currents are produced by the proboscides, two of which, as we have said, are situated at the mouth of each individual, so that in a tablet or plate, thirty-two, in all—twenty-four placed at the edges, and eight standing out from the centre—are brought into action.

The single animalcules (*fig.* 39) swim like the Monads, in the direction of the longitudinal axis of their bodies, with the mouth foremost, but the plates have a variety of movement: sometimes they move quite horizontally, at

others vertically, and then again on their edges, like the rotation of a wheel. A magnifying power of 200 times is sufficient for general examination; but to exhibit all the structures shewn in the engravings, four times that power will be required. Found in clear water, salt and fresh, near the surface. Discovered by Müller, in clear water, at Copenhagen, 1773. Size of animalcule from 1-460th to 1-1150th; ditto of tablet, not exceeding 1-280th.

76. GONIUM *punctatum. The spotted Gonium.*—Body composed of green corpuscles, spotted with black, and enclosed within a crystalline lorica. Found amongst conferva. Size of animalcule 1-4600th; a tablet of 16, 1-570th in breadth.

77. GONIUM *tranquillum. The tranquil Gonium.*—Body composed of green corpuscles within a crystalline lorica, as shewn at *figure* 43. Size 1-2880th; ditto tablet of 16, from 1-140th to 1-220th in breadth. Tablet sometimes twice as broad as long.

78. GONIUM *hyalum. The crystal Gonium.*—Body composed of transparent corpuscles within a crystalline shell. Found in stagnant water. Size 1-300th; ditto tablet of 20 to 25, 1-6000th in breadth.

79. GONIUM *glaucum. The blueish-coloured Gonium.*—Body composed of blueish-green corpuscles within a crystalline shell. The tablets vary in the number of animalcules—namely, from four to sixty-four. Found in sea-water. Size 1-5000th; ditto tablet, 1-500th in diameter.

Genus XIX. SYNCRYPTA. *The double-loricated globe Animalcules.*—This genus of the family Volvocina is mainly characterized by its secreting or hiding itself (as the name

implies) within a second envelope or shell. The individuals of the genus are each of them provided with a special lorica of their own, of the form of a little shield (*scutellum*), but being of a social character, they have besides a common envelope or gelatinous mantle (*lacerna*) into which they retreat or aggregate, as occasion shall require. They are deficient of both the eye and tail, but they have a large filiform proboscis, which vibrates, for the purposes of locomotion, &c. When the animalcules are in a cluster, these proboscides give it an appearance of being surrounded with hairs. The digestive sacs have not yet been perceived. Self-division takes place in a longitudinal direction.

80. SYNCRYPTA *volvox. The rolling Syncrypta.*—Body of an oval form and green colour, with whitish rays in the centre. Found generally in water drained from conferva. Size 1-2880th; ditto of a clustered globule in its crystalline tunic, hardly exceeding 1-570th.

This berry-like cluster of animalcules, when rolling through the water, is a beautiful object for the microscope, and, with the aid of a little indigo, the numerous currents it creates are readily perceived. The usual appearance of the clusters, as viewed under the microscope, and amplified 260 diameters, is given at *fig.* 45. *Fig.* 44 represents a cluster magnified 400 times, and *fig.* 46 a cluster as viewed by Ehrenberg, in its simplest state, when about to sever into four.

Genus XX. SYNURA. *The ray globe Animalcules* are characterized by being destitute of the eye, but provided with a filiform tail, which is attached either to the base of its own lorica, or to the centre of the cluster to which it

belongs. The general envelope is a gelatinous substance of a spherical form, and fitted up into as many compartments, or cells, as there are individuals in its little community to inhabit. From out of these cells they can severally stretch themselves a considerable distance, whilst they continue fastened, in the manner before described, by the extremely delicate and extensible tail.

81. SYNURA *uvella. The grape Synura.*—Body composed of oblong corpuscles, of a yellow colour, and capable of being stretched forth from their cells to three times their natural length, by means of the extensible tail. The cluster has the form of a mulberry, and its motion is a rolling one, like that of the Volvox globator. *Figure* 50 exhibits a cluster magnified, and *figure* 51 a portion of a cluster, to shew the manner in which the tails of the animalcules are inserted in the common envelope. This species, along with Syncrypta and Uroglena volvox, may often have been confounded with Uvella virescens. Length of body, exclusive of tail, 1-1700th; diameter of cluster, from 1-190th to 1-280th.

Genus XXI. UROGLENA. The *globe Animalcules, with ray and eye.*—This is the first genus of the family Volvocina which is distinguished by the possession of both the eye and tail. It is also a sort of compound animalcule, living in clusters under a common covering or mantle (*lacerna*), which is apportioned into cells for the accommodation of the several individuals. The self-division takes place simply and equally in these individuals, whilst remaining in their clustering condition. Within the mantle they are placed at uniform distances from each other, with their tails radiating from the centre, and by

means of which each animalcule is fixed to the base of its own special envelope. Each one is furnished with a filiform proboscis, which gives the appearance as if the whole sphere were covered with hairs. When the creatures divide, the mantle, or lacerna, only enlarges, without becoming separated itself. The visual organ is a red speck in the fore part of the body, and the tail is filiform, resembling that of the Vorticella and Bodo.

The internal structure of these compound animalcules can be verified only with instruments of superior quality, and require considerable skill in the management of them. This latter qualification is so indispensable, that notwithstanding many persons in this country possess better microscopes than those employed by Ehrenberg, the curious organization of these little creatures has hitherto eluded their observation.

82. Uroglena *volvox. The rolling Uroglena.*—Body composed of yellow corpuscles of an oblong form. Tail extensible from three to six times the length of the body, and even more. Cluster mulberry-shaped. There is little doubt but that single animalcules of this genus, seen in company with the clusters, have often been taken for creatures of a different family. Ehrenberg states that he has observed individuals with two or three eyes, which he conceives to have been a symptom of approaching self-division. *Fig.* 54 gives a magnified representation of a globular cluster of these animalcules, and *fig.* 53 a single one, in which the red eye is distinctly visible. Found in turf water. Diameter of cluster 1-90th.

Genus XXII. Eudorina. *The globe Animalcule with an eye.*—The characteristics of this genus are its absence of tail, but possession of the eye, which may be distinctly

seen, and a simple filiform vibratory proboscis, situated at the mouth, as its organ of locomotion, &c. Self-division is also undergone by the individuals simply and equally, whilst retaining their clustered position. These little creatures are endowed with the power of periodically casting off their globular lorica or mantle (*lacerna*) which envelopes the cluster, and exuding a new one, like certain animals of the class Annelides. To observe the eye a power of 300 diameters must be skilfully employed.

83. Eudorina *elegans. The elegant Eudorina.*—Body composed of green corpuscles, of a globular shape, never protruding out of their cells from the common envelope. Eye sparkling red. The clusters, which are of an oval or globular form, contain generally from 30 to 50 individuals, and never less than 15. Motion rotating. *Figure* 47 is a cluster magnified; it exhibits the proboscides extended, and the bodies of the animalcules within the lorica. Clusters of these beautiful animalcules are often seen in such amazing numbers, along with the Volvox globator and Chlamidomonas pulvisculus, as to render the water (otherwise colourless) of a decided green colour, especially towards its edges. They are exceedingly delicate, so much so, that it is difficult to preserve them alive for more than a day or two: whenever it is attempted to retain them in large quantities, the second day will generally exhibit a thick mass of dead ones at the bottom of the vessels. When a few only remain alive, if the water be poured away, and the creatures removed into a vessel of clear water, they will live for weeks. Found at Hackney and Hampstead; most abundant in the spring of the year. Diameter of cluster 1-180th.

Genus XXIII. Chlamidomonas. *The cuiras Monad*

Animalcules are characterized by being deficient of the tail, but provided with a beautiful red eye, indicating a sensitive system, and a double flagelliform proboscis, for the purpose of locomotion, &c. The shell-like envelope, which bears the form of a little box (*urceolus*) encloses the creature up to the mouth, and when the young have attained to maturity and self-division is to be completed, it bursts, to set them at liberty. The lorica is with difficulty perceived upon the young ones.

84. CHLAMIDOMONAS *pulvisculus* (*Monas pulvisculus*, M.) *The dust Monad.*—Body composed of green corpuscles, of an oval form, and included within a box-like shell. Eye brilliant red, and proboscis double. The clusters are globular, and made up of only three or four, or at most eight? *Group* 52 represents a single one; also a cluster about to separate into five, the latter enclosed in a common envelope.

These creatures form the larger portion of the green matter which gives colouring to the water contained in water-butts, ponds, and puddles, in the summer and autumn, and especially after a storm. It could hardly fail to have been observed so soon as any of this green water was examined under the microscope.

Wherever these creatures exist in great quantities, multitudes of them die; their bodies, and the envelopes cast off by the living ones, are decomposed, gaseous matter is generated, which, adhering, causes them to rise to the surface of the water, forming a green stratum upon it. Although the animalcules, and their coverings, when in this state, somewhat resemble Ulvaceae, yet are they easily distinguishable from them by the red speck or eye, which is retained for a considerable time after death, and the new

bodies may be seen connected together by means of an intervening membrane, formed of dead colourless Infusoria, and the remains of loricæ. Size 1-550th.

Genus XXIV. SPHAEROSIRA. *The rudder Animalcules.*—The distinguishing features of this genus are its being deficient of the tail, but possessing the eye, and a simple filiform rudder-like proboscis. Its method of self-dividing is different from that of any of the preceding genera, inasmuch as it occurs unequally within the envelope, when young clusters are formed at once from the parent ones. This genus differs, then, from the Pandorina in having the eye; from the Eudorina by its unequal mode of self-division; and from the Volvox by its simple proboscis. Self-division in these creatures takes place in the longitudinal direction, commencing in equal planes, so that lamina are produced as with the Gonium.

85. SPHAEROSIRA *volvox. The revolving Sphaerosira.*—Body composed of pale green corpuscles, of nearly a globular shape, enveloped in a lorica of the mantle form. Eye bright red. The cluster resembles a great ball of animalcules, containing small compressed clusters within it. *Fig.* 49 represents a portion of the tunic or lorica, highly magnified, so as to shew the different forms of the creatures located within it, namely, three single animalcules, one mulberry-shaped cluster, and one oblong group may be observed within that portion of lorica. *Figure* 48 represents a large spherical cluster. Found in considerable numbers in company with the Volvox globator, and often attains its size. Sometimes found by itself.

Genus XXV. VOLVOX. *The globe Animalcules.*—The genus Volvox, which is the type of the family Volvocina, was instituted by Linneus, and promulgated to the world in

1758, in the tenth edition of his *Systema Naturae.* This genus, as first described by him, comprehended the entire race of Infusoria, excepting only eleven of the tribe Vorticella, which were separated from them, under the denomination of Hydra, the two species of V. globator and V. chaos containing all the rest. In his twelfth edition (1766) of the same work, he distributes the Infusoria into four genera, viz., the Vorticella, Volvox, Hydra, and Chaos.

The Volvox is characterized by the members aggregating under a transparent shell-like lorica, of the form of a *hollow* globe, the creatures being distributed over the internal surface of it. Each animalcule possesses the red eye and a double filiform proboscis, which latter protrudes beyond the surface of the lorica, so as to give it the appearance (where great numbers of these creatures are assembled to form the globe) of being covered with cilia. Their different modes of increasing by self-division are especially characteristic of the genus.

Formerly the whole globular mass was regarded as a single warty or ciliated animalcule, and the bursting of the globe, whereby a few which had come to maturity and previously left their positions in the lorica, were liberated, was considered as the birth of the single animalcule. This theory Ehrenberg clearly proves to have been erroneous, and shews that a somewhat deeper research is necessary in order to determine the organic relations of the creature. The individual animalcules are the little green wart-like bodies or specks which are to be seen on the surface of the globe, and singly resemble Monads. They have the same relation to their globe as the indi-

viduals of the Gonium pectorale hold to their tabular clusters. Each sphere or globe is a hollow cluster, if we may so term it, of many hundreds or even thousands of these living occupants, and often contain within it other hollow spheres, similar in nature to the containing one.

The individuals are protected by a gelatinous lorica or mantle (*lacerna*), of the form of a bell, which they are empowered to leave when they are full grown. They are connected with their neighbours by from three to six filiform cords or tubes. The mouth is situated at the base of the double proboscis, before mentioned, and indicated by a bright spot. The eye, which is placed near the mouth, implies the existence of a sensitive system.

86. VOLVOX *globator* (M). *The globe Volvox.*—The creatures which form these clusters are extremely minute. A cluster is of nearly a spherical form, and will often contain within it younger clusters, of a green colour, and smooth or even surface. When blue or red colouring matter is mixed with the water, strong currents may be observed under the microscope around each globe, which, when in motion, always proceeds with the same part foremost.

Fig. 55 represents a large globe with eight smaller ones (termed by Ehrenberg, sisters) within it; each of them has a bright spot, which is considered as an opening for the admission of water into the interior.

Fig. 56 represents a section or piece of a globe, magnified 500 diameters; it exhibits five single animalcules and a small cluster of six young ones. They are attached to the lorica, and connected together by five thread-like bands. Each creature has a double proboscis and the red eye.

Fig. 57 represents a single animalcule, separated from its lorica, and magnified 2000 diameters. Found in shallow pools of clear water, in spring and summer, at Hampstead.

The largest globes measure 1-30th of an inch in diameter; the smallest free swimming ones 1-360th to 1-240th. Size of a single animalcule, 1-3500th.

87. VOLVOX *aureus. The golden Volvox.*—These animalcules are of a green colour, and nearly globular. The large clusters are in the form of a sphere, and the smaller ones within them of a golden colour, and smooth surface. Found in rain water standing on turf. Diameter of globe 1-36th.

88. VOLVOX *stellatus. The starry Volvox.*—These animalcules are small, of an angular form, and green colour. The clusters are subglobose, sometimes oblong, and contain other globes within them, of a green colour, and having their surfaces tuberculated or stellated. Diameter of globe 1-30th.

Family IV.—VIBRIONIA.

The animalcules of this family are distinctly or apparently polygastric, but without a true alimentary canal. In shape they are filiform, and, like the Monadina, are incapable of changing the form of their body. They have neither appendages or shell-like covering. They are associated or linked together in thread-like chains, formed by their imperfect mode of self-dividing, which takes place in a transverse direction. Considering how much we know of the organization of the family Monadina, we are comparatively far behind in information respecting the Vibrionia, and were it not that the cause of our ignorance is manifestly attributable to the exceeding minuteness of the individual animalcules, we might be justified in imagining their structure to be more simple than in all probability it really is. Their filiform and very delicate bodies are not, as we have said, separate animalcules, but formed of chain-like clusters, whose almost imperceptible links are themselves (at first) single creatures. The reasons to be assigned for arriving at this conclusion are, that the clusters or chains have never any determinate length, or number of members forming them, and that they are sometimes so short as to be made up of not more than two or three individuals, and only distinguishable from the M. termo and crepusculum by their mode of union, and peculiar, though not easily characterized, movements. Hence all their organic relationships are to be sought for in these minute portions of the chain. To

discover these is a task not to be fully accomplished, even with the greatest assiduity, attended by the most effective optical means which we at present possess. The traces of organization in the members of this family are so few, and those so indefinite, that a question might arise whether or not they are to be considered as belonging to the animal portion of the creation. The answer to this is, that they possess a very powerful writhing, and evidently voluntary state of locomotion; and in one genus (Bacterium), a single vibratory proboscis is present as the organ of motion. In it the individual forms are strung more slightly together, the filiform cluster not being able to exert the writhing movement seen in the true Vibrios, a direct movement in swimming being alone practicable. In Spirillum the constrictions or articulations are oblique, so that increase in length by division engenders a spiral chain.

This family is distributed among five genera, as follows:

Articulated threads (clusters). Straight, the divisions being rectangular and transverse	Inflexible		Bacterium.
	Flexible, like a snake		Vibrio.
Articulated threads spirally twisted (like a bell-spring or cork-screw) the transverse divisions being oblique	Flexible		Spirochoeta.
	Inflexible	with a cylindrically extended spiral form	Spirillum.
		with a disc-like compressed spiral form	Spirodiscus.

Genus XXVI. Bacterium. *The jointed-wand Animalcules* are distinguished by being connected together in a thread-like chain, of an inflexible nature, and their propagating by a transverse mode of self-division.

The three species known to us are colourless, and

extremely minute. Ehrenberg remarks, "that only one of the species has been satisfactorily determined, and that their organic relations are altogether so occult, that our judgment respecting them must unavoidably be left in a fluctuating state." In B. triloculare, organization is discoverable to the extent of a vibratory proboscis, a granulated mass within the body of the creature, and its faculty of spontaneous division. The only animal endowment common to all the species is an active and voluntary power of locomotion.

A magnifying power below 500 times linear will not exhibit the divisions or transverse lines where the individuals or links of which the wand-like cluster is composed are united. I have generally met with them around decomposed vegetable matter, on the surface of water containing chara, &c.

89. Bacterium *triloculare. The three-celled Bacterium.* —Chain consists of from two to five animalcules, of an oval form, developed in short cylinders, generally about three times as long as their diameter, and marked with transverse lines. Ehrenberg has observed not more than five links together nor less than two, a single animalcule never having fallen under his notice. By throwing a little colouring matter into the water, an evident vibration may be perceived in it near the anterior portion of the animalcule; and upon a very close inspection, a simple filiform, though short proboscis, is seen, which, in the larger specimens, is one-third the length of the body, and in the smaller, one half. The motion of this creature is tremulous, or slowly revolving upon its longitudinal axis. Found in the water of bogs. Length of cluster, 1-4800th

to 1-2304th; ditto of link, or single animalcule, 1-11520th. *Group* 58 represents several figures of them; those two towards the right are magnified 1000 diameters, the others 290.

90. BACTERIUM? *enchelys. The Monad-like Bacterium.* —Chain composed of somewhat indistinct animalcules, of an oval form, developed in smaller cylinders than the preceding, transverse lines faintly marked, colourless. Found in river water. Length of cluster, 1-2880th.

91. BACTERIUM *punctum. The point-like Bacterium.*—Chain composed of indistinct animalcules, approaching to a globular form, much smaller than the preceding species, and developed in cylinders, transverse lines faintly marked, colourless. Found in water wherein bread has been steeped. Length of cluster, 1-4032nd.

Genus XXVII. VIBRIO. *The trembling Animalcules.*—This genus is characterised by the animalcules being connected together in filiform chains, of a flexible nature, resembling the body of a snake. These chains, as we have already remarked, are produced throught he creatures incomplete mode of self-dividing. The difficulty of ascertaining the internal organization of this genus has not as yet been surmounted, although it is fair to presume that there is nothing of a tubular character, or intestinal canal, running along within their filiform bodies, similar to that of the vinegar eels, or it would most probably have been demonstrated before now, by the aid of coloured food; for a *line* is much more easily distinguished than a *point.* Ehrenberg supposes, that each link in the chain is a closed, round, Monad-like body, having a nutritive apparatus of a polygastric description.

92. Vibrio *lineola*. *The line Vibrio.*—Cluster, a minute cylindrical and slightly flexible wand, rounded at both ends, and made up of bodies somewhat indistinct, but of nearly a globular form, and colourless. Commonly found in vegetable infusions, especially round the stalks of flowers in glasses. Length of wand, from 1-3600th to 1-12000th. Thickness 1-36000th.

93. Vibrio *tremulans*. *The tremulous Vibrio.*—Wand short; stouter, yet more flexible, than the preceding; articulations of an oblong form, but not distinct. Found in water emitting a disagreeable odour. Length of wand, 1-3600th.

94. Vibrio *subtilis*. *The delicately-formed Vibrio.*—Wand slender and elongated; colourless; articulations distinct; motion slightly vibrating, without varying the direct position of the articulations. Length 1-450th. Thickness 1-24000th.

95. Vibrio *rugula* (*Volvox lunula et Vibrio regula,* M.) *The wrinkled Vibrio.*—Wand elongated, and stouter than the preceding; articulations distinct, and colourless; motion brisk and serpentine; common in infusions. Length 1-580th. Thickness 1-12000th.

96. Vibrio *prolifer*. *The prolific Vibrio.*—Wand short, stout, and colourless; articulations distinct. Motion slow and tortuous. Found in infusions where mildew is present. Length 1-1100th.

97. Vibrio *bacillas*, (M.) *The wand-like Vibrio.*—Wand stout, elongated and transparent; articulations sometimes distinct, at others only so when taken from the water and dried; motion serpentine, but straight when quiescent. *Group* 59, represents three wand-like

clusters of these creatures. Found in vegetable infusions in fetid water. Length 1-200th. Thickness 1-17200th.

Genus XXVIII. SPIROCHAETA. *The twisting Animalcules.*—This genus is characterized by its members being developed in filiform and flexible chains, of a spiral description, which are elongated by the imperfect or incomplete mode of the creatures' self-division. The details of their organization are at present unknown to us.

98. SPIROCHAETA *plicatilis* (*V. serpens,* M.) *The worm-like or writhing Spirochaeta.*—Chain constituted of very delicate bodies, of nearly a globular shape, connected together in a long filiform spiral form, having numerous and closely arranged coils; colourless. *Group* 62 shews three clusters. Found at Tilbury Fort. Length of chain 1-170th to 1-440th. Thickness 1-12000th.

Genus XXIX. SPIRILLUM. *The cylinder spiral Animalcules.*—This genus is characterized by its members developing themselves in tortuous chains, or inflexible and cylindrical spirals. These are elongated in the same manner as before described, by the incomplete self-division of the creatures, which takes place in an oblique direction. Their brisk, energetic, and voluntary motion, and the increase of the chain by division, are the only animal properties which have been hitherto observed as characterizing the creature.

99. SPIRILLUM *tenue.* *The slender Spirillum.*—Spiral consists of three or four coils, constituted of very slender, slightly bent, and colourless fibres; articulations distinct. Found in vegetable infusions. Length about 1-900th. Thickness 1-12000th.

100. SPIRILLUM *undula* (*V. undula,* M.) *The wavy*

Spirillum.—Spiral consists of one and half turns; fibres short, stout, and much bent; articulations distinct; colourless; when dry, the articulations are more distinct. Ehrenberg remarks, that the form of this species is like a bow; and Müller, that it resembles the letter V. *Fig.* 61 represents a group magnified 800 diameters; that with dotted lines indicates the impression left on the eye when the creature is in motion. Found in stagnant water having a mildewy scent. Length about 1-1500th. Thickness 1-20000th.

101. Spirillum *volutans* (*Vibrio spirillum,* M.)—*The twirling Spirillum* or *screw Vibrio.*—Consists of three, four, or more coils; fibres very tortuous, long, and stout; articulations distinct; colourless. Found in vegetable infusions. Length of spiral 1-2200th to 1-500th. Thickness 1-14400th.

This creature strongly resembles the minute Algae discovered by Mr. Thompson, as producing the various colours which the Ballydrian Lake assumes, and which he has described under the name of *Anabaina spiralis,* in vol. v. of the *Ann. Nat. Hist.*; his figures resemble *group* 61. The genus is characterized as "consisting of extremely minute moniliform thread, of a rich green colour, and regularly spiral, like a corkscrew; globules of equal size throughout." In decomposing, it changes first to blue and then ferruginous; each globule appeared to consist of a number of granules enveloped in a hyaline membrane. Length of a single coil about 1-200th.

102. Spirillum *bryozoon.* *The moss Spirillum.*—Coils consist of a thick body, with a delicate wavy hair-like proboscis. These creatures, found in the reproductive

organs of plants, are called by their discoverer, Dr. Unger, of Gratz, spermatic animalcules. That distinguished botanist has described them in detail in the *Regensburger Botan. Fictung. Flora,* 1834; and also in the 18th vol. of the *Nova Acta Naturæ cur. Bonn,* 1838. As a condensed view of this subject is given by Dr. Meyen in the *Jahres-bericht* (a work, the like of which England does not possess), for 1838, I shall here insert the translation I have had made, with the drawings Dr. Unger kindly sent me for this work:—

"The spermatic animalcules in sphagnum consist, according to the earlier observations of Unger, of a thick body, and a thin filiform tail; in motion, this tail being anterior, he holds it analogous to the proboscis of many of the Infusoria. No true active motion of the body itself has been observed by Unger; but he distinguishes between the mere locomotive and rotatory movements of the whole animalcule. The simplest motion takes place in a spiral direction; and, if the proboscis is contracted, the movement is simply rotatory. During locomotion of the creature, which ensues in a spiral direction, Unger saw from one to three revolutions of the body in a second; and during rotation, he noticed the point of the proboscis to be in a continual state of tremor. Unger endeavours to shew that the spermatic animalcules of the mosses are analogous to the spermatic animalcules of animal organisms, although we find certain things in the former not seen in the latter, and which may somewhat embarrass their classification, the chief of which are the steadiness of the spiral direction of the proboscis, and their manner of movement. Lately, Unger has found spermatic animal-

cules in the antheridia of Polytrichum juniperinum, P. commune, P. urnigerum and P. alpestre, as well as in Funaria hygrometrica, Bryum cuspidatum, and B. punctatum, &c. &c. In Polytrichum commune, the animalcules are found in very small hexædral cells with rounded corners. Generally, whilst in the cells they are motionless; in some, however, a tremulous motion of the thin proboscis, and in others, again, a rotatory motion, interrupted at intervals, was seen. The diameter of the delicate proboscis is 0.004th of an inch. In a few animalcules, isolated from their cells, a trembling oscillating motion of the proboscis was seen."

To these particulars, I may add a remark of Dr. Unger, quoted in the *Ann. des Sciences Nat.*, which induced me to introduce the species :—

"The doubts," says Unger, "which remain concerning some of the organs of the animalcules of mosses further increase the incertitude as to their situation in the scale of beings. From all circumstances, I am inclined to place them in the genus Spirillum of Ehrenberg, and to describe them under the name of Spirillum bryozoon."

On mentioning these particulars to Mr. Varley, he referred me to his article on Chara, in the 50th vol. *Trans. Soc. Arts,* from which is extracted the following :—

"From these cells" (in the globule in the axile of the Chara) "grow out numerous clusters of long vessels, possessing the most extraordinary features yet observed. When these are first protruded from the globule, if not quite mature enough, their appearance is like dense or strongly-marked ringed vessels, the divisions of which, or their contents, soon begin to appear irregular. * * * After

a while, these curls within the divisions become agitated; some shake, or vibrate about; others revolve in their confined places, and many come out, thus shewing that they are spirals of two or three curls; these with an agitated motion swim about * * *. Now the field of view appears filled with life; great numbers of these spirals are seen agitated and moving in all directions; they all have a directile force, one end going foremost, and never the other; many stray a great way out of the field: these, by getting clear of each other, are the best to observe; they do not quite keep their form as a stiff spiral, but their foremost end seems to lash about, and to many are seen attached almost invisible but very long fibres. These fibres were in quick undulations, which ran in waves from the spiral to their farthest end. It appears that these fibres cause many of the spirals to entangle together, and thus bring them sooner to a state of rest; therefore, the separate ones were best to observe."

The most recent observations on these creatures, found in the anthers of the Chara vulgaris and hispida, are by M. Thuret, given in the *Annal. des Sciences*, a valuable translation of which will be found in the *Annals of Natural History*, vol. vii., from which I extract the following:—

"The portion of their body most apparent appeared like a spirally-rolled thread, of three to five curves. They were slightly tinged with green, similar to the nuclei; and, like them, turned brown with iodine, their two extremities becoming more or less coloured (according to the quantity of iodine employed) than the rest of the body, thus indicating a difference of nature in these portions. At

a little distance behind one extremity proceed two bristles, or tentacula, of excessive tenuity, which the animalcule incessantly agitates with great rapidity. These are probably organs of locomotion, similar to the filiform prolongation, found in the Infusoria without cilia. Indeed, the part thus furnished with tentacula moves foremost, drawing after it the rest of the body, which turns about in the water, but always preserves its turriculate form. The incessant agitation of these tentacula, and their extreme tenuity, rendered it impossible to observe them in the living animal; recourse was therefore had to the evaporation of the water, or to the application of a slight tincture of iodine, when the animalcules ceased their motions, became contracted, and their spiral unrolled, when the tentacula were rendered very distinct, from their brown colour. These tentacula were frequently observed to be soldered together, from one-half to one-third of their length upwards, but others were also noticed to be entirely separated down to their bases. A swelling similar to that in the flexure of the body was perceived in their curves.

"Ammonia arrested their motions, and contracted the body gradually into a small oval mass, but did not produce the phenomenon of decomposition by solution (*diffluence*), so remarkable in the Infusoria. A very weak solution of chlorhydric acid in water violently contracted them into a shapeless mass."

In *plate* xii., *fig*. 519, 520, and 521, represent the spermatozoa found in Polytrichum commune, the first figure exhibiting them enclosed in the cellules, and the others swimming freely. *Figures* 522 to 524, are taken from Marchantia

polymorpha. *Figure* 525 is from Sphagnum capillifolium. All the above are represented magnified 1000 diameters. *Figures* 526 to 528 are from the Chara vulgaris, and *figures* 529 to 531 from Jungermannia pinguis, as figured in Meyen's work, entitled *Neues System der Pflantzen.*

Genus XXX. Spirodiscus. *The disk-spiral Animalcules* are characterized by developing themselves, through an imperfect self-division taking place in an oblique direction, in elongated chains, or into inflexible spirals, of a disc-like figure. Its organization is so little known that Ehrenberg considers the genus as by no means satisfactorily determined.

103. Spirodiscus *fulvus. The yellowish-brown Spirodiscus.*—A lenticular spiral, of a yellowish-brown colour. Articulation indistinct. *Group* 62 represents three spirals, magnified 200 diameters. Found amongst conferva. Breadth of spiral 1-1200th.

Family V.—CLOSTERINA.

The animalcules of this family are polygastric, or to all appearances so, and destitute of an alimentary canal. Their bodies are unvarying in form, and without any appendages. Like the Cryptomonadina, they are enclosed within loricated envelopes, which, simultaneously with their bodies, undergo incomplete self-division, so as to form polypi-shaped clusters, of a wand, thread, or fusiform figure. Each individual is furnished with a papilla, or sort of nipple, which protrudes, but very slightly, through an aperture in the shell, and serves as an organ of locomotion.

The envelope, or lorica, investing these creatures, is of the form of a little pitcher (*urceolus*), and either of a yellowish colour, or colourless. In many of the species it is open at both ends. The animalcule itself is a very delicate mucous body, clear as crystal, and often contains within it vesicles and green granules, which latter are most probably ova. The locomotive organs appear to be very short, slender, and conical-shaped papillae or nipples, of a transparent hue, placed just within the opening of the lorica, and but very slightly protruding from it. The small vesicles observable among the green ova are, in all probability, belonging to the polygastric apparatus. *Groups* 63 to 67 illustrate this family.

As several eminent botanists have considered the various species included in this family, and the family Bacillaria, as belonging to the vegetable and not to the animal

kingdom, I have had a translation made of the remarks of Dr. Meyen on this interesting subject, which will be found prefaced to the latter family, and reserve to myself the opportunity of discussing the subject more fully there.

It should be borne in mind, however, that in treating of this matter, the descriptive characters of them, and the illustrative drawings, will not be in the least reduced in value or interest, whether they are considered as forming a portion of the animal or vegetable creation. To the microscopist the members of this family possess much interest, arising from the circulation of the particles within, near the ends of the shell, and also along the sides. For these observations an amplifying power of 400 diameters, at least, is required; but even a single lens of that power will shew it.

Ehrenberg gives the following reasons for placing the Closterina in the animal part of the creation:—First, they exert a voluntary motion, as shewn first by Corti. Secondly, they have apertures at their extremities, as noticed by himself. Thirdly, they have projecting organs near these apertures, perpetually in motion. Fourthly, they increase and multiply by a transverse self-division, as observed by Müller. These four endowments Ehrenberg considers as being abundantly sufficient to determine the real nature of the Closterina, inasmuch as, wherever voluntary motion, an aperture or mouth (feet), and spontaneous division exist, you may conclude at once, *without waiting to see the creature eat*, that the supposed plant is indeed an animal.

Since the above was written, some interesting obser-

vations have appeared, in No. xxxiii. of the *Annals of Natural History*, by Mr. Dalrymple, from which I select the following; my intention in this work being not to confine it to my own views, but also to record those of others, believing that, by so doing, I shall best serve the public, and advance this science.

Mr. D. describes the Closterium as consisting of "a green gelatinous and granular body, invested by a highly elastic and contractile membrane, which is attached by variable points to a hard siliceous shell." This lorica, Mr. C. Varley states, will resist even the action of boiling nitric acid. The form of Closterium is spindle-shaped or crescentic, the shell consisting of two horns, tapering off more or less to the extremities, and united at the central transverse line, constituting a perfectly symmetrical exterior. At the extremity of each horn is an opening in the shell, which, however, is closed within by the membranous envelope—wanting, however, in some specimens. Within the shell, and at the extremity of the green body, is a transparent chamber, containing a variable number of active molecules, measuring from the 20,000th to the 40,000th of an inch; these molecules, or transparent spheroids, occasionally escape from this chamber, and circulate vaguely and irregularly between the periphery of the gelatinous body and the shell. Further, the parieties of this chamber have a contractile power. The author denied the existence of any papillae or proboscides at this part, as well as the supposition of Ehrenberg, that these moving molecules constitute the bases of such papillae. He also denied the statement of the same distinguished observer, that if colouring matter was mixed

with the water in which the Closterium resides, any motion was communicated to the particles of such colouring matter by the supposed papillae, or by the active molecules within the terminal cells. A circulation of the fluids within the shell was observed, independent of the vague movements of the active molecules; this was regular, passing in two opposite currents, one along the side of the shell, and the other along the periphery of the gelatinous body. When the shell and body of the Closterium was broken by pressure, the green gelatinous matter was forcibly ejected by the contraction of the membranous envelope.

The action of iodine upon the specimens was very remarkable: 1st, it did not, as reported by Meyen, stain the green body violet or purple, but orange-brown: 2nd, it produced violent contraction of the investing membrane of the body, whereby the green matter was often forcibly expelled from the shell at the transverse division; it instantly annihilated the motion of the molecules in the terminal sacs, and the sacs themselves became so distended with fluid as to burst, and allow the molecules to escape.—The following are Mr. D.'s reasons for classing it with animals:—

"1st. That while Closterium has a circulation of molecules greatly resembling that of plants, it has also a definite organ, unknown in the vegetable world, in which the active molecules appear to enjoy an independent motion, and the parietes of which appear capable of contracting upon its contents.

"2ndly. That the green gelatinous body is contained in a membranous envelope, which, while it is elastic, con-

tracts also upon the action of certain re-agents, whose effects cannot be considered purely chemical.

"3rdly. The comparison of the supposed ova with the cytoblasts and cells of plants precludes the possibility of our considering them as the latter, while the appearance of a vitelline nucleus, transparent but molecular fluid, a chorion or shell, determines them as animal ova. It was shown to be impossible that these eggs had been deposited in the empty shell by other infusoria, or that they were the produce of some entozoon.

"4thly. That while it was impossible to determine whether the vague motions of Closterium were voluntary or not, yet the idea the author had formed of a suctorial apparatus forbad his classing them with plants.

"Lastly, in no instance had the action of iodine produced its ordinary effects upon starch or vegetable matter, by colouring it violet or blue, although Meyen asserts it did in his trials."

The author therefore concluded that Closterium must still be retained as an infusory animal, although it is more than doubtful whether it ought to rank with the polygastric families.

Genus XXXI. CLOSTERIUM. *The spindle Animalcules.*—This genus comprehends all the known members of the family; the characteristic features of the latter, therefore, answer for the genus. Twenty-seven species have been described, although but sixteen are clearly determined.

104. CLOSTERIUM *lunula* (*Vibrio lunula*, M.) *The half-moon-shaped Closterium.*—Lorica smooth, crescent-shaped or straight, attenuated and rounded at the apices. Glandular substances scattered over the interior of the

body, and the green granules arranged in fillets, about ten in number. Average length 1-50th.

105. CLOSTERIUM *moniliferum* (*Vibrio lunula*, M.) *The pearl or necklace-bearing Closterium.*—Lorica smooth, crescent-shaped, never straight, attenuated and rounded at the apices. Pellucid glandular substances in the middle of the body arranged in a single series, like a string of pearls (Moniliferum), and several fillets of green granules, three in the centre more distinct than the rest. Length 1-120th.

106. CLOSTERIUM *Dianae. The bow-shaped Closterium.* —Lorica smooth, more gracefully crescented, greatly attenuated, and sharper at the extremities than the preceding species; glands disposed in a single series along the middle of the body, with several green longitudinal rays, straight or curved, but somewhat obscure. Found in turf-water. Length 1-120th.

107. CLOSTERIUM *acerosum* (*Vibrio lunula*, M.) *The needle-shaped Closterium.*—Lorica smooth, straight, and spindle-shaped, gradually attenuated towards the obtuse extremities, green; glands arranged in a single series along the medium line, and rays numerous, but obscure. This species has been mistaken for C. lunula. The normal form of this animalcule is represented by *fig.* 65. *Fig.* 63 is a representation after self-division has ensued, and *fig.* 64 is one cut asunder, so as to shew it in the act of separating from its shell or lorica. Found in brook-water. Length from 1-400th to 1-50th.

108. CLOSTERIUM *trabecula. The beam-shaped Closterium.*—Lorica smooth, straight, cylindrical, constricted at the middle, and truncated at both extremities; green;

glands dispersed, or placed in a number of series; rays obscure. Found among oscillatoria. Length 1-140th to 1-60th.

109. CLOSTERIUM *digitus. The finger-shaped Closterium.*—Lorica smooth, straight, ovato-cylindrical, four times as long as broad, and considerably rounded at the ends. Traces sometimes of a triple self-division, and longitudinal fillets undulating along the edges. Found amongst conferva. Length 1-240th to 1-120th.

110. CLOSTERIUM *attenuatum. The slender-formed Closterium.*—Lorica smooth, crescented, or slightly curved, and tapering considerably towards the extremities, which are obtuse; glands in a single series along the middle, with no central transverse rays. Length 1-48th.

111. CLOSTERIUM *cornu. The horn-shaped Closterium.*—Lorica smooth, very slender, slightly curved, and approaching to cylindrical, with the apices truncated. Fillets green, undulating. Found amongst conferva. Length 1-900th to 1-120th.

112. CLOSTERIUM? *cylindrus. The cylinder-shaped Closterium.*—Lorica ovato-cylindrical; scarcely three times as long as broad, slightly constricted at the middle, and very obtuse at both extremities. Marked exteriorly with granulated radiations of the shell. Length 1-430th.

113. CLOSTERIUM *margaritaceum. The pearly Closterium.*—Lorica straight, cylindrical, and elongated, eight or nine times as long as broad, and slightly constricted at the middle, rounded at both extremities, and marked exteriorly with strings of pearl-like granules; moveable points at some distance from the extremity. Length 1-240th to 1-200th.

114. Closterium *turgidum. The turgid Closterium.*—Lorica stout, slightly curved, and approaching to cylindrical, a little attenuated at both ends, apices of a reddish colour, and rounded; obscurely marked with smooth striæ. This is one of the largest species of the genus, and was formerly mistaken by Ehrenberg for the C. ruficeps, on account of the red apex. The delicate streaks or markings of the lorica, which may be considered as the main characteristics of the species, had been overlooked. *Fig.* 66 represents a living Closterium, having three animated (?) clusters of granules within it; the lorica is supposed to be opened, the mass of green matter being ova. Length 1-140th to 1-60th.

115. Closterium *lineatum. The lined Closterium.*—Lorica of considerable length, often thirty times as long as broad, slender, and slightly curved; cylindrical and filiform at the middle, but greatly attenuated and truncated at both extremities. It is distinctly marked with smooth lines. Found amongst conferva. Length 1-200th to 1-36th.

116. Closterium *striolatum. The striated Closterium.*—Lorica spindle-shaped and arcuated, ten to twelve times as long as broad; slightly attenuated and truncated at both ends. It is obscurely marked with smooth striæ. Found amongst oscillatoria. Length 1-120th.

117. Closterium *setaceum. The bristle-shaped Closterium.*—Lorica spindle-shaped, straight, or very slightly arcuated, and almost insensibly striated, having setaceous horns, each horn being longer than the body. The empty shell-like projections, which Ehrenberg has designated setaceous horns, are rounded at the extremities, but so attenuated as not to allow of any openings being seen.

Ehrenberg states that he discovered this species in May, 1832; and that in August, 1835, he observed the copulative process in operation, when some peculiarities were exhibited. On the issuing forth of the green matter, separation took place into four instead of two portions, and the green matter formed itself into a flat eight-cornered body, with a bright spot in its centre, and granulated contents. In *group* 67, the two slender figures on the left side shew their general form, the different positions of the moving points within, and the appearance of the horns. The figure on the right side exhibits the formation of double gemmae, a single creature being by this mode of self-division increased four-fold. Found amongst conferva. Length, including horns, 1-96th; without the latter, 1-430th.

118. CLOSTERIUM *rostratum. The beaked Closterium.*—Lorica slender, spindle-shaped, slightly curved, and much attenuated at both extremities, striated, each horn, beak, or bristle-like extremity, barely as long as the body, often shorter. Length 1-120th to 1-48th.

119. CLOSTERIUM ? *inequale. The unequal Closterium.*—Lorica spindle-shaped and crescented, striated, and of a tawny colour; horns unequal, the one blunted, the other long, slender and sharp. Found amongst conferva. Length 1-430th.

Family VI.—ASTASIAEA.

This family is characterized by its members being polygastric, and deficient of the true alimentary canal, appendages, or lorica. They are furnished with a single aperture to the body, and often a tail, and have the power of changing their form at pleasure. They afford as beautiful living objects for the microscope as any that have ever fallen under my observation. The tail may be considered as an organ of locomotion, and the single proboscis of three of the genera, and the double proboscis of one other genus, are of the like description. It is probable that these latter organs exist also in the genus Colacium, although they have not been determined ; but in the Distigma there is hardly a doubt of their absence. The vesicular cells have been supposed to form a portion of the nutritive apparatus, although it is not satisfactorily demonstrated by the application of coloured food. Ehrenberg has, nevertheless, noticed some manifestations of an artificial action having been produced, as he observed green and red cells in the Euglena viridis. Three genera in this family exhibit signs of the hermaphrodite condition, whilst the other three, Astacia, Distigma and Colacium, have only one kind of structure, namely ova. In the Euglena there may be seen, in addition to the green ova and seminal glands, a contractile vesicle of a seminal description, and the large red visual point in five of the genera affords evident tokens of a system of sensation. What, however, may be deemed most worthy of remark in this family, is, that in the species,

Euglena longicauda and amblyophis we have the first indications of the presence of nervous matter that is to be found in the polygastric Infusoria: it appears in the form of a white glandular knot, situated below the eye.

The following table is descriptive of the genera of this family:—

Eye wanting					Astasia.
Eyes present	With one eye	free	with one proboscis	tail wanting	Amblyophis.
				tail present	Euglena.
			with two proboscides		Chlorogonium.
		attached by a pedicle			Colacium.
	With two eyes				Distigma.

Genus XXXII. Astasia. The members of this genus are characterized by their being free (not attached by a pedicle), and being furnished with a long or short tail, but no eyes; Astasia pusilla is the only species in which digestive cells have been clearly seen. Ova are perceptible in Astasia haematodes, and probably exist in the three other species; a locomotive organ in the form of a thread-like proboscis exists in A. pusilla.

The immense numbers in which these Infusoria are developed in a few days, and the blood red-colour they assume, have not unfrequently been the cause of considerable alarm and anxiety to persons residing in the vicinity of the waters wherein they are found.

120. Astasia *haematodes. The blood-like Astasia.*—Body fusiform, or spindle-shaped, when extended; tail very short, body green at first, afterwards of a blood-red colour. *Group* 68 represents one creature extended, and another contracted. (Hampstead). Length 1-380th.

121. Astasia *flavicans*. *The yellow Astasia.*—Body extensible, cone-shaped, approaching cylindrical, and rounded at the foremost extremity. Tail very short and blunt; ovaria of a yellowish colour. Found in yellow ditch water. Length about 1-430th.

122. Astasia *pusilla*. *The dwarf Astasia.*—Body extensible, cone-shaped, swelling out, and rounded at the foremost extremity; tail very short and pointed, colourless. *Group* 69 represents two of them magnified.

Ehrenberg remarks, they are often so abundant, that thousands, perhaps millions, of these creatures are sometimes contained in the hollow of a watch-glass, and that they rise up and form a stratum on the surface of the water. They might have been mistaken for the young of the A. flavicans, but that the vesicles within them, which appeared to be digestive cells, were larger than those in that species, which is also without proboscis. As soon as a little colouring matter was thrown into the water, an evident current was observed near the fore part of the creature; and by this means, in 1833, the thread-like proboscis, which is about half the length of the body, was first perceived. Sometimes the entire creature appeared to glisten. Should this species, upon closer inspection, be found to be ciliated, it would be rightly placed in Peridinea. Length 1-1440th to 1-840th.

123. Astasia (?) *viridis*. *The green Astasia.*—Body extensible, and of an ovato-oblong form, distended a little at the middle; tail very short and pointed; green. Found amongst conferva. Length 1-1200th to 1-900th.

124. Astasia *nivalis*. *The snow Astasia.*—Form oval, extremities rounded, rarely pear-shaped, colour deep

reddish-brown, motion rapid. (See 72.) Found with Protococcus nebulosus in snow (Switzerland). *Plate* xii. *group* 526. Length 1-1500th.

Genus XXXIII. Amblyophis. *The tail-less eye Astasiaea.*—The characteristics of this genus are, that its member is free, possesses an eye and single thread-like proboscis, but is tail-less. This proboscis serves as an organ of locomotion, and is situated at the creature's foremost extremity, which, says Ehrenberg, is cleft, so as to represent a two-lipped mouth; the upper lip bearing the proboscis being very readily distinguished. The colour of the animalcule is derived from the closely compressed mass of green granules, which nearly fills the body, and may be regarded as ova. There may be seen also, near the middle of the creature, a large bright globular body, and five wand-like bodies, two of which are situated before, and three behind, the first mentioned one. The whole of these are supposed to be male generative organs. No contractile spermatic vesicle has been observed. Self-division is unknown in these creatures. The sensitive system is more beautifully and clearly developed in this genus than in any other of the polygastric Infusoria. Towards the anterior part of the body, and just behind the proboscis, where the mass of ova commences, there is a bright red and somewhat lengthened spot (resembling, as to situation and colour, the eye of the wheel Animalcules and Entomastracea), beneath which, in the clear space below, is a quantity of matter of a very peculiar description, of a globular form, having the appearance of nervous ganglia, and being most probably connected with the organ of vision.

125. Amblyophis *viridis*. *The green Amblyophis.*—

Body large, elongated, cylindrical, distended or compressed, and abruptly rounded at the posterior extremity; green; head colourless; eye large, bright red. The motion of this creature is dull and serpentine, and by its evolutions might easily be mistaken for the Euglena spirogyra, were that creature, like this, tail-less. *Group* 70 represents three specimens, one full grown, and the others young. Found among Euglena, chiefly in the spring. Length 1-210th to 1-140th.

Genus XXXIV. *Euglena. The eye Animalcule.*—This beautiful genus of the family Astasiaea is characterized by its members being furnished with an eye, a single thread-like proboscis, and tail, and by their being free, that is, not attached by a pedicle. The locomotive proboscis belongs to nine species out of the eleven, and a double appearance of this organ has been observed in the Euglena sanguinea, ascribable, no doubt, to the preparatory condition of the animalcule for self-division.

In E. hyalina, pleuronectes, and longicauda, nutritive cells are generally visible, but in the other species they are obscured by the masses of green ova, which give this colouring to their bodies. Certain internal appearances have been recognized, which Ehrenberg supposes to be of a generative nature, and to belong to the male kind. Longitudinal self-division has been observed in E. acus, and the preparation for it in E. sanguinea, as before mentioned. The red visual point indicates the existence of the sensitive system in this genus, and a nervous ganglion is visible in E. longicauda, as in amblyophis.

126. Euglena *sanguinea* (*Cercaria viridis*, M.) *The blood-red Euglena.*—Body extensible, of an oblong cylin-

drical or spindle-shaped form, with the head greatly rounded; the tail is short, conical, and somewhat pointed. Proboscis longer than the body in its extended condition. When young, they are green, but when full grown, are of a blood-red colour. The motion of this variform animalcule is generally slow, and it sometimes revolves upon its longitudinal axis in swimming. Its colour is not of a fixed character, some being green, others spotted red and green—a mixture of both. This arises, according to Ehrenberg, from the different condition of the ova at different times, and which cover numerous granular round bodies, supposed to be digestive cells. The thread-like proboscis, which is a prolongation of the upper lip, and rather longer than the body, is so delicate, as to require considerable care in investigating it, and being retractile, will often elude our observation. A little colouring matter in the water will exhibit this organ in active operation, and it may be distinctly seen in a single animalcule, in a dried state, upon a plate of clear glass. The double appearance of the organ in this species has been before noticed. Ehrenberg conjectures that the miracle in Egypt, recorded by the great lawgiver of the Jews, of turning the water into blood, might have been effected by the agency of these creatures, or by the Astasia hæmatodes. *Figures* 71, 72, and 73, represent the creature in different states. In the first, it appears elongated, and currents in the water are shewn near the mouth. In the others, the cilia-formed thread-like proboscis is seen. Found in stagnant water; often in great abundance on the surface of ponds. Length 1-300th to 1-240th.

127. EUGLENA *hyalina*. *The crystal-like Euglena.*—

Body extensible in a spindle-shaped manner, with the head attenuated, blunted at the extremity, and two-lipped; tail short, and somewhat pointed; colour transparent and whitish, rare. Length 1-280th.

128. Euglena *deses* (*Enchelys deses*, M.) *The slothful Euglena.*—Body extensible and cylinder shaped, abruptly rounded at the head, and slightly bi-lipped. Tail very short and pointed; colour green; motion a winding and sluggish creeping, never swimming. Found amongst lemna. Length 1-240th to 1-760th.

129. Euglena *viridis* (*Cercaria viridis*, M.) *The green Euglena.*—Body extensible in a spindle-shaped manner, with the head attenuated and short. Tail short, and cone-shaped, not cleft; colour green, excepting the two extremities, which are colourless. The double-pointed tail, supposed to have been seen by Leeuwenhoek, Ingenhousz Müller, Schrank, and Nitzsch, does not exist. The colour of the eye is often pale red, when the creature is young, so that it may be easily mistaken for the Astasia viridis or Monas deses. When dried on glass, the eye seldom retains its colour more than a week, but the proboscis may be well examined, and preserved in this state. Length 1-240th.

130. Euglena *spirogyra*. *The tortuous Euglena.*—Body extensible and cylinder-shaped, very finely striated and granulated. The head is a little truncated, and the hinder part attenuated into a short pointed tail; colour a brownish-green; motion like E. deses. Found amongst conferva and Bacillaria. Length 1-240th to 1-120th.

131. Euglena *pyrum*. *The pear-shaped Euglena.*—Body obliquely fluted; when distended oval or pear-shaped.

The tail is generally about the length of the body and pointed; colour green. *Group* 74 represents two of these creatures magnified 400 diameters. Rarely found with any other species. I have taken them at Hampstead, but not so frequently as the other species. Length 1-1152nd to 1-864th.

132. Euglena *pleuronectes* (*Cercaria pleuronectes,* M.) *The plaice-shaped Euglena.*—Body compressed, ovato-orbicular, or in the form of a leaf; striated longitudinally; colour green; tail pointed, one-third or one-fourth part the length of the body, and colourless. Found in stagnant water. Length 1-1152nd to 1-480th.

133. Euglena *longicauda. The long-tailed Euglena.* —Body mostly stiff, compressed, illiptical and leaf-like; colour green; tail the length of the body, awl-shaped, and colourless. Within this creature may often be seen a yellowish-green mass of granules or ova. The very delicate vibrating thread-like proboscis represented in the *figs.* 75 and 76 originates from the more projecting part of an indentation on the anterior edge of the body, and is about two-thirds its length. This creature has the power of twisting its body into a spiral form, as seen in *fig.* 75, but not of contracting it. It swims freely, and mostly with a vibratory motion, occasioned by the action of the proboscis. Found in fresh water, amongst conferva, and with the Bacillaria. Length 1-480th to 1-120th.

134. Euglena *triquetra. The three-sided Euglena.*—Body leaf-shaped, three-sided, oval-keeled; colour green; tail shorter than the body, and colourless. See *fig.* 77. Found amongst lemna. Length 1-580th.

135. Euglena *acus* (*Vibrio acus,* M.) *The needle-*

shaped Euglena.—Body slender, spindle-shaped, and straightened in the form of a bodkin; head attenuated, and a little truncated; tail very pointed; body green in the middle, and colourless at the extremities. This is one of the most beautiful animalcules I have seen under the microscope; its graceful form when swimming, its bright red eye, the curious forms it assumes when stationary, and its remarkable appearance when undergoing self-division, all combine to render it worthy of observation. *Group* 78 shews the normal form of this creature; the figure to the right, the same bent and contracted; and the lower, another undergoing longitudinal self-division. Found both in fresh and brackish water. Length 1-570th to 1-210th.

136. Euglena *rostrata. The beaked Euglena.*—Body elongated and conical, with the hinder part gradually attenuated into the tail, which is very short. Head slightly bent, like a beak; colour green. Found amongst oscillatoria and Bacillaria. Length about 1-500th.

Genus XXXV. Chlorogonium. *The Astasiaea with a double proboscis.*—This genus comprises those members of the family Astasiaea which are provided with an eye, tail, and double thread-like proboscis; their motion in swimming is free, the creature not being attached by means of a pedicle or foot-stalk. The only known species is of a very beautiful green colour, and has numerous transparent vesicles within it, which are apparently subservient to the purpose of nutrition, although this fact has not been determined by the application of coloured food. A faint, clear, glandular body, most probably belonging to the male generative system, is perceptible in the centre of

the animalcule, the female being apparent in the mass of green ova, which gives the colouring to the creature. The double proboscis is used as an organ of locomotion, and the bright red eye affords the usual evidence of the existence of a system of sensation. Self-division in the transverse direction, somewhat modified, has been observed to take place.

137. CHLOROGONIUM *euchlorum. The beautiful green Chlorogonium.*—Body spindle-shaped, very pointed at both extremities; tail short; colour a sparkling green. The eye of this animalcule, although distinctly marked, is, nevertheless, so delicate, that it may be easily overlooked; but when the creature is dried upon a plate of very clear glass, both the eye and the double proboscis are readily seen, and may be well preserved as a permanent microscopic object. *Group* 79 represents six creatures in one cluster, each with its double proboscis; above them is one about to self-divide into three; and on the right of this are three young animalcules. Found in water-butts, &c.: on ponds it forms the green matter of Priestly. Length 1-1150th to 1-280th, exclusive of the tail.

Genus XXXVI. COLACIUM. *The friends? of the Water Flea.*—This genus is characterized by the creatures belonging to it being endowed with a single eye, and attaching themselves to other bodies by means of a pedicle or foot-stalk, which is single, or ramified by the act of self-division. The usual locomotive proboscis has not been defined in this genus, although, as Ehrenberg remarks, there can be no doubt of its existence, by the currents which are visible in coloured water near the forepart of the body. This motion of the water being rather

feeble, renders it probable that the organ is a single filiform proboscis. The red visual point is indicative of a system of sensation, and the numerous transparent vesicles within the body denote one of nutrition. The creatures are parasitical upon Entomostracis and Rotatoria.

138. COLACIUM (?) *vesiculosum. The bladder-shaped Colacium.*—Body of a spindle-shaped oval form, but variable, with the pedicle very short, and seldom ramified; colour, a sparkling green, with distinct internal vesicles. Ehrenberg says, "I have again sought in vain for the red eye (May 23, 1835), but cannot be satisfied of its non-existence, as it is undoubtedly present in the other species, and investigation is sometimes unproductive, on account of subordinate circumstances. I have likewise failed in seeing very satisfactorily the vibratory organ, notwithstanding its action is evident enough." In *plate* ii., *fig.* 80 represents a portion of the back shield of the Cyclops quadricornis (see *Microscopic Cabinet, plate* ix.), with six of these creatures attached to it; one appears double, longitudinal self-division having just taken place. Found upon Entomostraceans. Length 1-860th.

139. COLACIUM *stentorinum. The trumpet-shaped Colacium.*—Body expansible and variable, somewhat cylindrical in form, anterior expanded into a cone or funnel-shape; colour, a beautiful green; vesicles indistinct, pedicle often ramified. Found upon Entomostraceans and Polyarthra trigla. Length 1-1150th.

Genus XXXVII. DISTIGMA. *The double-eyed Astasiaea.*—The characteristics of this genus are the creatures being possessed of two eyes, and a freedom of motion. Locomotive organs have not been hitherto discovered, and the

presumption is, that they do not exist externally, as none of the species either swim or produce currents which are perceptible in coloured water. They have a sort of creeping or crawling movement, much like eels, and can change their forms, after the manner of the Proteus; they approximate the Amoeba in other relationships than in respect of their being deficient of the proboscis. At the fore part of the body may be seen two very delicate blackish-coloured spots, analagous to the eyes in the species of other tribes. They are sometimes confounded with the Proteus diffluens of Müller. All the species are exquisite objects for a deep powered microscope, namely, 460 times.

140. Distigma? *tenax* (*Proteus*, M.) *The tenacious Distigma.*—Body the largest of the genus, proteus-like, at times greatly distended, then as much constricted; eyes rather indistinct; colour transparent yellow. Found about lemna. Length 1-240th.

141. Distigma *proteus* (*Proteus*, M.) *The colourless Distigma.*—Body smaller than the preceding, proteus-like, sometimes greatly distended, at others constricted, blunted at both extremities; eyes distinct. *Group* 81 represents these creatures highly magnified. Found amongst conferva. Length 1-580th to 1-400th.

142. Distigma *viride*. *The green Distigma.*—Body the least of the genus, proteus-like, sometimes greatly distended, at others constricted; filled with green granules; eyes distinct. Length not exceeding 1-570th.

143. Distigma *planaria*. *The eel-shaped Distigma.*—Body small, linear, proteus-like, but less distended or constricted than the preceding, pointed at both extremities; colourless; eyes distinct. Found by Ehrenberg amongst conferva in water of the Nile. Length 1-240th.

Family VII.—DINOBRYINA.

The animalcules of this family are distinctly, or to all appearances, of the polygastric description, and furnished with only one aperture to the body; hence it has no true alimentary canal. They are without any appendages, but possessed of a lorica or shell, and have the power at will of changing their forms. In one species of the genus Dinobryon a simple filiform proboscis is present; and in the same genus, a delicate red spot, at the anterior portion of the body, indicates the organ of vision. The nutritive apparatus is faint and undefined. The lorica is of the form of a little pitcher (*urceolus*), at the bottom of which the very contractile Euglena-like creature is attached. Two genera only are known.

Genus XXXVIII. Epipyxis. *The pedestal Animalcule.*—The characteristics of this genus are mostly of the negative kind, namely, its lacking the eye and retaining the body in a sitting posture. The most evident animal character possessed by the species is the funnel-shaped orifice at its foremost extremity. The soft or pulpy body is seated within a delicate membranous (not siliceous) lorica, which is usually affixed by a pedicle, or foot, to a piece of conferva.

145. Epipyxis *utriculus. The bottle-shaped Epipyxis.*—Body of a conical pitcher-like form, small, and filled with yellowish granules; attached by a pedicle. *Group* 82 represents several of these creatures attached to a portion of conferva. Length 1-640th.

Genus XXXIX. Dinobryon.—This genus is distinguished from the preceding one by the species possessing

an eye, and enjoying a freedom of motion. The lorica also is more free from the body of the creature than in the Epipyxis, and from the sprouting forth of buds, which do not separate from the parent; hence a shrubby, forked, and Monad-like cluster is produced.

146. Dinobryon *sertularia.* *The fruticose Dinobryon.*—Body large, invested with a lorica, slightly excised, and dilated at the mouth, but constricted near the base. Developing in the form of a shrub. (See *group* 83 and *fig.* 84.) This animalcule is not readily seen, by reason of its crystalline lorica, and colourless body: by a patient investigation, however, the little shrubby colony may be perceived rolling along, and advancing in the field of view. Within each lorica a pale yellow animalcule may be noticed, in form somewhat resembling the young of the Chlorogonium or Euglena viridis. This creature has the power of stretching itself out in a spindle-shaped manner, so as not to protrude, however, beyond the mouth of the lorica, and also of contracting itself into a globular form. The red visual point is observable at the anterior part of the body, and a single thread-like proboscis is thrust forth from out the shell. *Cluster* 83 represents a shrubby cluster, containing eight animalcules, and the shells of three which have died. The vibrating proboscides act like so many paddles in the water, and propel the moving mass. Found in bog-water. Length of single animalcule 1-570th; ditto of cluster 1-120th.

147. Dinobryon (?) *sociale.* *The social Dinobryon.*—Body small, enveloped in a shell of a simply conical shape, truncated at the mouth. Developed in the form of a shrub. Found in fresh water. Length 1-860th; ditto of cluster 1-280th.

Family VIII.—AMOEBAEA.

The infusorial animalcules of this family are polygastric, with one aperture only to the body, and no alimentary canal or lorica. No other organs of motion are observable than certain appendages or ramifications, consisting of variable pediform processes, which they have the power of putting forth from every part of their gelatinous and contractile bodies, and by which they move from place to place. The organs of nutrition are composed of numerous digestive cells, which are visible in all the species, either in their natural state, or by the introduction of coloured substances into them. Self-division has been seen in Amoeba diffluens. No indications of a sensitive system are discoverable in any species. As only one genus is known in this family, it is exemplified by the family characteristics.

Genus XL. Amoeba.

148. Amoeba *princeps* (*Proteus diff.* M.) *The great Amoeba.*—Body of a pale yellow colour, furnished with numerous variable processes, somewhat cylindrical in form, with the terminations thick and rounded. This curious creature, from its slow motion and yellowish colour, is a desirable object for the microscope; its singular changes of form, and its internal organization, may be viewed with considerable pleasure, even under very high magnifying powers. Its normal shape, if such it can be said to possess, is globular, but it can relax any portion of its body, and contract the rest, so as to force the internal part down into this relaxed portion, in a manner

resembling an hernial tumour; ten or twelve processes may sometimes be seen extended at one time. *Figures* 85, 86, and 87, represent three animalcules highly magnified; the first has only two processes extended; in the last there are several. Found amongst Navicules. Size 1-140th to 1-70th.

149. Amoeba *verrucosa. The short-footed or warty Amoeba.*—Body less than that of the last species, and colourless; processes very short and blunted, resembling warts; motion sluggish. Size never exceeding 1-240th.

150. Amoeba *diffluens* (*Volvox sphoerula,* M.) *The dissolving Amoeba or Proteus.*—Body expansible and colourless; processes longer than the last, strong and more pointed. This species is a very interesting object for the microscopic observer; its body resembles sometimes a transparent, at other times a turbid lump of jelly, slowly expanding and stretching itself out, and here and there exhibiting its pointed processes, which again disappear as it advances. Its motions may be compared to those of a many-footed animal tied up in a sack. Found in Hackney Marsh, amongst lemna. Usual size about 1-300th.

151. Amoeba *radiosa. The radiant Amoeba.*—Body colourless, and less than the preceding species; its processes, which are numerous, are long and slender, pointed at the ends, and apparently radiating. This animalcule, when in a contracted state, is not distinguishable from the A. diffluens, but when fully expanded may be likened to the porcupine. It readily imbibes colouring matter. *Fig.* 88 resembles one of these creatures in a contracted state, and 88* the same with the processes thrust forth. Found in bog-water. Size 1-240th.

Family IX.—ARCELLINA.

This family contains polygastric animalcules, who possess an alimentary canal, a single opening of the body, are provided with a lorica, and who can change their figure by means of the variable pediform processes with which they are furnished. The lorica, which is univalved, is pitcher or dish-shaped, and the possession of it is the chief feature distinguishing this from the family Amœba. The body is soft and gelatinous, and in some cases appears to flow as it were from the opening of the lorica. The organs of locomotion are soft variable processes, situated at the anterior part of the body; they are sometimes withdrawn, at others protruded; sometimes they appear simple, at other times branched; they are neither feet nor antennæ, but a peculiar locomotive apparatus. In five species, numerous digestive vesicles are seen. No traces of a sensitive system have been discovered. The reproductive system is unknown, neither has increase by self-division, the formation of gemmae, or otherwise, been recognized.

The genera are related to each other as follows:—

Changeable processes radiant, generally numerous	Lorica spherical or tun-like......	Difflugia.
	Dish or shield-shaped	Arcella.
Changeable processes broad and undivided		Cyphidium.

Genus XLI. Difflugia. *The diffluent Animalcules.*— This genus is characterized by the creatures having the variable processes, which issue only from the fore part of

the body, numerous, or each one cleft into several parts, so as to give it the appearance of being many. The body is enveloped in a pitcher-like lorica, sometimes globular, and at others oblong or spiral in form. The lorica of this genus being opaque, except that of D. enchelys, little of the internal organization of these creatures is known; in the D. enchelys numerous digestive cells have been seen. In the D. proteiformis and D. acuminata, the lorica is covered with grains of sand, similar to that of the caddis-worm. In D. oblonga and D. enchelys, the shell is smooth.

152. Difflugia *proteiformis. The varying Difflugia.*—Lorica ovate and subglobose, as represented in *figs.* 89, 90, and 91: it is roughly coated with minute grains of sand, and is either of a blackish or greenish colour. The transparent processes vary in number from one to ten. In *fig.* 89, six are protruded. M. Le Clerc mentions their having spiral corrugations on the lorica, which Ehrenberg does not appear to have seen. Found among oscillatoria, &c. Size 1-240th.

153. Difflugia *oblonga. The oblong Difflugia.*—Shell oblong, with the back rounded, smooth, and of a brownish colour. The transparent processes fewer and stouter than those of the preceding species. Found among oscillatoria, &c. Length 1-200th.

154. Difflugia *acuminata. The pointed Difflugia.*—Shell oblong and rough, being covered with minute grains of sand, posterior pointed; processes transparent. Length 1-70th.

155. Difflugia *enchelys. The flask-shaped Difflugia.*—Shell oval; colourless; transparent and smooth, rounded

on the back. Processes transparent, slender, and small. A lateral aperture is seen in this species, which is the smallest of the genus. Found in stagnant water. Size 1-550th.

Genus XLII. ARCELLA. *The capsule Animalcules.*—The characteristics of this genus are, its being possessed of numerous variable processes, or single processes, cleft into many, and spread abroad, and its being furnished with a flattened shield-like lorica. The structure of the lorica, as to details, is very different in the different species. For instance, in A. vulgaris it exhibits regular and delicate facets. In A. dentata, the facets are large and crystalline. In A. aculeata, it is beset with spiculi; and in A. hyalina, it is homogeneous and clear. The organs of locomotion are evidently extensile and retractile processes, radiant and variable. The digestive cells are readily filled with coloured vegetable substances. In A. vulgaris, a contractile vesicle has been perceived.

156. ARCELLA *vulgaris*. *The common Arcella.*—Lorica round and bell-shaped, with an hemispherical or turgid back; smooth, and composed of rows of minute granules; colour yellow or reddish-brown. Found abundantly amongst lemna and aquatic plants. Size 1-570th to 1-240th.

157. ARCELLA *aculeata*. *The spinous Arcella.*—Lorica hemispherical, though of ten mis-shapen and spinous at the margin. It is formed of short spiculi, and is of a yellowish colour. The spines sometimes issue from only one-half of the margin of the shell, or shield-like lorica; the shell is not readily destroyed by heat. *Fig.* 92 represents one of these creatures. The projecting spines, and the large round opening in the lorica, are visible. *Fig.* 93 represents

another creature with three spines projecting from its lorica, and a single variable process issuing from the under side; the digestive cells may also be seen. *Fig.* 94 shews an empty deformed lorica. Diameter of lorica 1-210th.

158. ARCELLA *dentata. The toothed Arcella.*—Lorica membranous and homogeneous; of an hemispherical or polygonal form, having the margin dentated; colour yellowish or greenish. Found amongst conferva. Size 1-570th to 1-240th.

159. ARCELLA? *hyalina. The crystal Arcella.*—Lorica membranous, smooth, and approaching to globular, smaller than the preceding; colourless. Found in matter precipitated from water, along with Cyphidium aureolum, &c. Size 1-1150th to 1-570th.

Genus XLIII. CYPHIDIUM. This genus is distinguished by the creatures having only one dilated variable process, and a lorica of the form of a pitcher, with protuberances issuing from it. It forms a connecting group between Arcella and Bacillaria, by reason of the simple locomotive organ (like a snail's foot), and approaches very closely to the group Desmidiacea. The lorica is something like a little die or stamp, mounted upon a short stem. It is very irregularly formed, having protuberances so as to make it appear four-corned; it is combustible. The organ of locomotion is a broad, gelatinous, variable process, with smooth edges, resembling in appearance the body of Amoeba verrucosa. Neither digestive cells or apertures in the lorica have yet been observed, nor systems of sensation or propagation.

160. CYPHIDIUM *aureolum. The gold-coloured Cyphidium.*—Lorica of a cubical form, with protuberances;

process colourless. In March, 1835, says Ehrenberg, "I first observed hundreds of these creatures in a glass of water, which had stood throughout the winter, in company with some specimens of the Microsterias. Previously to discovering these, the Amoeba verrucosa had been abundantly generated; and, after their discovery, Arcella hyalina. The creatures were inactive, although, with attentive observation, they might be seen to change their places." Ehrenberg only once perceived the locomotive organ of the animalcule, situated under one corner, upon which it appeared to rest, and that so firmly, that six out of the eight protuberances of the die-like lorica were visible at the same time. *Fig.* 95, 96, and 97, represent these creatures in different positions. In the second, the gelatinous variable process is seen projecting from beneath the lorica; in the other two figures, the lorica only is visible. *Fig.* 98 is a young specimen. Size 1-570th to 1-430th.

Family X.—BACILLARIA.

This family is very extensive. It is deeply interesting to the geologist, from the recent discovery of the remains of several genera in various portions of the earth's structure, either forming by themselves, or with argillaceous earths, strata of great extent; or, when imbedded in various stony formations, as flint, agate, semi-opal, &c., clearly demonstrating their production subsequent to the existence of those interesting creatures.

The first observers of this family considered its members as animals; but by far the greater number of modern naturalists regard them as plants, and place them among the minute Algae; hence it is we stand mainly indebted to the botanist for our knowledge of their forms and localities.

A few of the genera are considered by some philosophers as forming connecting links of the animal, vegetable, and mineral kingdoms. Ehrenberg (whose skill and practice in the use of the microscope has been very great) affirms they are decidedly animal, and characterizes the family as comprehending all animalcules, distinctly or apparently polygastric, destitute of alimentary canal, the body furnished with variable undivided processes, and covered by a lorica or shell. While undergoing self-division they appear connected together, as it were, by a percurrent thread, so that they form chain-like or tabulated groups. The lorica of each animalcule has one or more openings,

and at the places where these creatures are connected together it is effected by means of soft processes protruding through these openings. Excepting the genera Navicula, and one or two others, they never separate spontaneously into single individuals, but always adhere, forming polypi-like masses of greater or less extent; hence it is that the term imperfect self-division has been applied to their mode of propagation.

As this family is of such vast importance in a geological point of view, and naturalists are so divided as to the natural position of its members, it will be desirable to enter into a few general particulars respecting it, to which I shall append an abstract of Dr. Meyen's views, they being unknown to the English reader.

The composition of the lorica or shell of these creatures is various, and may be separated into two kinds; the first containing silica, either pure or in combination with the oxide of iron, forming a silicate of iron; or secondly, those in which silica is entirely absent; the lorica has then a membranous or parchment-like (structure) texture. It is remarkable that in no case has lime been found to enter into their composition. In some genera the lorica is surrounded by a soft gelatinous variously-formed envelope or induvium. The shape of the lorica is various, but such as entirely to inclose the animalcule (hence it is termed *urceolate*), except the parts where it is united with others. When such is the case, and it is surrounded on all sides, the lorica is composed of two or more shells, or pieces, termed valves, which are usually dish or cup-shaped, and often fluted or grooved. Those in which silica enters into the composition have usually a round or a prismatic four-

sided figure, while in the non-siliceous they are generally flat, with three to five sides.

Of the internal organization of these creatures little is known, owing to their opacity, and the structure of the enveloping lorica. In many, however, large transparent variable vesicles are seen among the mass of coloured granules which occupy the greater part of the lorica. These vesicles are considered by Ehrenberg to be digestive cells, and the coloured mass ova, while the latter is the Chloriphylle of botanists. In some species, as soon as the coloured ova is protruded the parent dies; in others, the ova form a Monad-like mass, and when matured the parent separates from it; hence, says Ehrenberg, has arisen the opinion of the transition of animals into plants. In Microsterias, Arthrodesmus, and one or two other genera, says Dr. Ehrenberg, male reproductive structures are visible, but no trace of a sensitive system has been discovered.

From the clustering nature of this sluggish family, and the rigidity of their coverings, they resemble the confervoid Algae, and other minute vegetable forms, and are hence confounded with them; but in their mode of propagation a distinction may be recognised. In the Bacillaria, the self-division is always longitudinal, so that the conferva-like forms are not composed of long slender and filiform bodies, like plants, but of short and broad filiform portions. Sometimes the self-division is from back to front, or from side to side; the single creatures are then band-like or half-mōon-shaped.

In Acinata, organs of locomotion are visible, as feelers; but these creatures deviate so much from the Bacillaria in

other characteristics, that it is more proper to separate them from this family. In Navicula alone has an undivided locomotive organ been seen. This organ possesses the power of moving in any direction, and accommodating itself to any form similar to that curious muscular organ, the tongue, in animals, or the foot-like process of snails.

The shells of these creatures are often sculptured with deep flutings; where this occurs, the inside of the shell is not always smooth, but follows the form of the exterior: thus the strength is greatly increased, while the quantity of solid material employed in their construction is not augmented. The flutings in the living specimens being filled with coloured matter, are discerned with difficulty, and hence they are almost unknown. In the fossil state, in which vast numbers of these are found, the shells are empty, and in this state the flutings and other indentations become distinctly visible. I have, therefore, in the engravings illustrating this family, selected drawings of several in both states, so that the reader may form a clear conception of their true characters, while the interest attached to the family generally is so great, and we possess so few drawings of its various species, that I have been induced to extend the number of illustrations considerably. The order of their arrangement differs from that given in the plates of *Die Infusionsthierchen;* in that work the species and genera are placed in plates indiscriminately, and no regular arrangement is observed. As some fossil specimens have been discovered since Ehrenberg's great work appeared, I have had drawings of the finest I could procure made for me; some of them are the last productions of my friend, the late F. Bauer, Esq.;

so that the numerous illustrations of this family, whether the members be considered as animal or vegetable, will, I believe, be highly acceptable both to the botanist and naturalist.

In this family we are not only presented with the simplest forms of organic matter, but, from their numbers and the indestructibility of their shells, they have led to many important discoveries. The large masses of meteoric paper which fell in 1686 have recently been shewn to consist mainly of their coverings, while several hundred square feet of a flannel-like substance, lately found near Sabor, in Silesia, after an inundation, was composed of Fragillaria, Navicula, Cryptomonas, and Closterina, interwoven with Conferva rivularis.

As microscropic objects, the markings of the fossil species are highly interesting; and when mounted as opaque objects, a verification of the structure of their shell is clearly demonstrated.

The English specific names are taken from the German. In the *Natural History of Animalcules*, I have taken them from the Latin; this will account for the non-agreement.

The grand divisions of this family are into single and double-loricated animalcules; the genera comprised in the first being separated into those which are *attached* to a pedicle or stalk, and those which are destitute of such appendage, or *free*.

The Bacillaria comprehend the following genera :—

- Lorica simple.
  - Free.
    - One valved. (*Desmidiacea*).
      - prism shaped
        - three-sided ...... Desmidium.
        - four-sided ...... Staurastrum.
        - five-sided ...... Pentasterias.
      - globular
        - smooth ......
          - clusters moniliform ...... Tessararthra.
          - do. berry-like ...... Sphaerastrum.
        - spinous ...... Xanthidium.
      - flat ...
        - band-like ......
          - compressed or lying together Arthrodesmus.
          - united by serritures...... Odontella.
        - plate or disc-like ...
          - many in each plate or disc Micrasterias.
          - two ditto ...... Euastrum.
          - single and disc-like ...... Microtheca.
    - Two or more valved. (*Naviculacea*).
      - round
        - spherical, simple ...... Pyxidicula.
        - forming coral-like clusters
          - 1-celled, articulated filiform Gallionella.
          - many celled, concentrically Actinocyclus.
      - prismatic
        - self-division complete, never band-like
          - six openings to lorica ... Navicula.
          - four ditto ...... Eunotia.
          - one ditto ...... Cocconeïs.
        - division *in*complete, forming band-like clusters
          - jointed
            - wand-like ...... Bacillaria.
            - plate-like ...... Tessella.
          - jointless (fragile)
            - bands straight Fragilaria.
            - bands spiral ... Meridion.
  - Attached. (*Echinellea*).
    - single individuals broader than long ...... Isthmia.
    - do. longer than broad
      - stalkless, sessile
        - formed as a wand (prism-shaped) ...... Synedra.
        - formed as a wedge ...... Podosphenia.
      - stalked
        - wedged-shaped ......
          - dichotomous by long. div. Gomphonema.
          - whorled or radiating by do. Echinella.
        - lance-shaped, attachment direct ...... Cocconema.
        - banner-like, attachment oblique
          - a central opening ...... Achnanthes.
          - no central opening...... Striatella.
- Lorica double.
  - Covered with an amorphous mass of gelatine ...
    - scattered ...... Frustulia.
    - connected in a ring-like manner ...... Syncyclia.
  - Covered with membranous or gelatinous tubes ......
    - tubes simply branched
      - spiculi straight ...... Naunema.
      - ditto crooked ...... Gloeonema.
    - ditto aggregated, bundle-like
      - slit like a bunch...... Schizonema.
      - branched like a tree ...... Micromega.

Appended group.—Lorica simple, singly stalked, soft-valved, with many retractile (not vibratile) Tentaculae ...... Acineta.

In order that the reader may form a correct judgment on this subject, I have had translated the following remarks on the family Bacillaria, by Dr. Meyen (*Tahresbericht,* Berlin, 1839) :—

"Dr. Ehrenberg has described and represented, in his great work upon the Infusoria, a very considerable number of organized bodies, looked upon by botanists as belonging to the vegetable kingdom. In these representations, naturalists have been able to attain what has been long desirable; for, although in respect to the more highly developed and complete vegetable beings the truest delineations are indispensibly necessary at the present day, it is much more requisite that *every one* of these lower and microscopic organisms should be laid before us in the same tangible manner. To the systematist, it is of no import whether these beings are represented as plants or animals, for one thing is certain—*they will always remain what they are.* In this work, Ehrenberg has not only given systematic descriptions of these questionable animals or plants, but his own observations, coupled with those of his predecessors, upon the nature of these bodies, are found copiously detailed. This, however, is apparent; all the facts known upon the subject are interpreted in a manner as if these creations were undoubtedly animals, whilst the same facts would indicate quite a different signification if we proceeded upon the supposition that they were nothing but plants. It now becomes a question as to which view is right, or whether we are able to prove positively either one or the other. The subject, however, is one of high importance, and we shall say a few words upon it, bringing forward those genera as illus-

trations of the subject, which, according to my own opinion, are decidedly composed of plants. The first little plant we find described and represented in Ehrenberg's work is Gonium (?) tranquillum (E.) This I discovered in 1828, gave a representation of it, and afterwards named it Merismopedia punctata. Ehrenberg himself has observed nothing animal with respect to this plant, which belongs to the Ulvaceae, and distinguishes itself remarkably by its continual regular self-division. The members of the genus Closterium belong just as decidedly to the vegetable kingdom as does the Gonium; but the following reasons are adduced by Ehrenberg as proofs of their animal organization. They possess voluntary motion; they have openings at the extremity; they possess continually-moving even protruding organs immediately behind the openings, and they are endowed with transverse self-division. But all plants, says Ehrenberg, which are endowed with voluntary motion, open orifices, feet, and self-division, we may look upon as animals, without waiting to see them eat. That this last resolution is correct, no doubt all botanists will accede to; but the following considerations are those which incline to the opinion of the vegetable nature of the Closterina. The structure of the Closterina is evidently that of the Conferva, as well as the formation of their spores or seeds, and the development of them. The existence of amylum within the Closterina is a striking proof of their vegetable nature. They are likewise destitute of feet, for what Ehrenberg took for these appendages are self-moveable molecules, as are seen in Closterium trabecula, to the number of 5 or 600, or more, and filling a canal running

along the whole length of the plant. The function of these bodies is very difficult to determine; but they are to be found in very many conferva, and are perhaps to be likened to the spermatic animalcules of plants.

"Under the great family Bacillaria Ehrenberg has brought thirty-five to thirty-six genera; but which may be more properly divided into two separate families—the family of the true Bacillaria, and that of the Desmidiacea. This last family has already been firmly settled by Menegheni, and includes those true Algae upon whose nature there can be no doubt. To the true Algae belong the following genera of Ehrenberg's Bacillaria:—Desmidium, Ag.; Staurastrum, Mey.; Pentasterias, Ehr.; Sphaerastrum, Mey.; Xanthidium, Ehr.; Scenedesmus, Mey.; Odontella, Ag.; Pediastrum, Mey. (Micrasterias, Ag.); and Euastrum, Ehr. In all these genera, nothing has yet been observed which can be adduced as evidences of their animal nature. Actual motion, arising from internal causes, I saw only in Sphaerastrum; and the slight movement, supposed to have been observed in some of the genera, is certainly of the same description as that of some conferva, which sometimes vegetate far below, at other times upon, the surface of water; but this elevation from the deep is generally connected with visible evolution of gaseous matter. The increase by self-division occurs in all these genera; this process is looked upon by Ehrenberg as one of the strongest and most decisive characters of animal nature; but I have elsewhere proved, in the most satisfactory manner, that self-division is very common, both in the lowest plants as well as in the elementary organs of the more highly developed ones. The little vesicles

endowed with molecular motion, seen in the genus Euastrum, are completely indentical with those observed in Closterium and the conferva, and I see no good reason why Closterium should not be placed near Euastrum. The green corpuscles observed within the cells of most of the Desmidiacea are similar to the green corpuscles found in the cells of the conferva ; and though Ehrenberg may consider them as ova, I have observed their development into spores, and in several genera have distinctly seen that they contained amylum, and sometimes that they were even entirely composed of it.

"The second section of the Bacillaria includes the true Bacillaria, and are indicated by the term Naviculacea; here are to be found those numerous forms, which, from their occurrence in a fossil state, have lately given rise to such a great degree of interest, and which Ehrenberg, and many other naturalists, regard as undoubtedly belonging to the animal kingdom.

"The reasons adduced for such belief, however, are so weak, that the conclusions deduced from them are yet, for the most part, very doubtful.

"The movement of the Bacillaria, however free it may be, is by no means so free and active as that of the spores of the Algae and the spermatic animalcules, which are plants, or at least parts of plants, and the motion is no very positive ground for the belief of their animal condition. The common mode of propagation seen in Bacillaria is that of self-division, which is also proper to the cells of the higher plants; the increase by spores or ova ensues but rarely. The form, structure, and especially the habitus of the Bacillaria are evidently of that kind to lead

one to consider them as plants; but the following circumstance, which is of very considerable interest, militates against it. In many Naviculæ, it it observed that the molecules, such as of indigo or carmine, &c., in the same solution, that may come into contact with the surface of the body of the creature, are immediately set in motion, and often run along with considerable rapidity by the side of the body, and even turn and run in an opposite direction. This remarkable appearance has its cause, perhaps, in the existence of numerous delicate cilia, which are present over the surface of the creature, and giving rise to the motion.

"With our present instruments we cannot take cognizance of these organs; but when making use of a very high power, a sort of transparent narrow zone is observed around the bodies of the Bacillaria.

"Lastly, Ehrenberg adduces another observation as satisfactorily proving the animal nature of the Bacillaria. They sometimes receive colouring matter, which fills the vesicles looked upon by him as stomachs. This last statement appears at least very striking, but the way in which the case stands seems to be somewhat different. In the first place, I can see no stomach sacs in the Naviculæ, and never observed in the living and moving Bacillaria the colouring matter received at one extremity and carried towards the centre, where these stomach sacs should lie, whilst in the Infusoria such observations are easy; on the other hand, it is not rarely found, especially with the larger living animalcules, that the molecules of the colouring matter employed lie upon the middle of the broad ventral surface, from which it appears as if the colour-

ing material was really existing internally; but if a glass plate is placed upon it, and then properly removed, the globule of colouring matter may be taken away. The unprejudiced reader must then see that much observation is yet wanting ere we can hope satisfactorily to determine that the Bacillaria are truly animals; and how closely plants and animals border upon each other is recognizable in the spermatic animalcules of the lower plants, and the spermatic animalcules of animals."

SECTION I.—DESMIDIACEA.

Genus XLIV. DESMIDIUM. *The chain-wanded Animalcules.*—The lorica is of a simple triangular box-like form, with a single aperture in the centre; in texture it resembles parchment. The animalcules possess the power of slowly transporting themselves from one place to another, but no organ of locomotion has been detected. Green ova-like granules are observable in all the species, and among them in D. Swartzii, orbiculare, and aculeatum, colourless vesicles, probably digestive cells. It is doubtful, says Dr. Ehrenberg, whether they are developed singly or in pairs.

161. DESMIDIUM *Swartzii. Swartz's Desmidium* has a triangular lorica, which, when viewed edgeways, appears quadrangular. They are attached together, forming a chain-like body, of a green colour. Diameter of a single animalcule 1-2300th to 1-1100th. Found amongst conferva.

162. DESMIDIUM *orbiculare. The disciform Desmidium*

is smooth, three-sided, with the angles rounded. When two are united, they appear orbicular. Size 1-570th. Found amongst conferva.

163. DESMIDIUM *hexaceros.* *The six-horned Desmidium* is represented in *plate* ii., *group* 99; the figure to the left is a separate one viewed in front, the other an edge view of four. They are generally connected in pairs; hence it is usual to see six corners or horns. This species never forms a long chain-like body, four (as shewn in the engraving) being the greatest number attached. The body is green; but the lorica, when empty, is quite colourless, and then exhibits a distinct central opening. Size 1-570th.

164. DESMIDIUM *bifidum.* *The double-toothed Desmidium.*—The three angles of the lorica of this creature are notched, hence each appears like a double tooth. Size 1-570th. Found amongst conferva.

165. DESMIDIUM *aculeatum* resembles D. hexaceros; covered with spines. Size 1-576th. Found in turf-water.

166. DESMIDIUM *apiculosum.* *The rough Desmidium* has the three angles of its lorica rounded, and is rough. Size 1-860th. Found in peat-water.

Genus XLV. STAURASTRUM. *The cross-star Animalcules* are characterized by their being free, and possessing a simple univalved four-sided lorica. They are sometimes, perhaps, developed in a filiform chain. No locomotion has been observed; indeed their only resemblance to an animal, even as stated by Ehrenberg, is their increase by self-division, though he thinks the green matter within them ova.

167. STAURASTRUM *dilatatum.* *The broad Staurastrum* has a membranous square uniformly-granulated lorica, with an opening in the centre, as shewn in *fig.* 101, which is an empty lorica, magnified 300 times; they are either single or attached in pairs, the latter is shown at *fig.* 100. Size 1-570th. Found amongst conferva.

168. STAURASTRUM *paradoxum.* *The slender Staurastrum* is shewn at *fig.* 102 and 103, one of which is a yellow, and the other a green, variety. They are either solitary or connected in pairs. Young observers are liable to mistake other forms of Bacillaria for this species; but its rough granulated surface is a special character. Size 1-1200th to 1-570th.

Genus XLVI. PENTASTERIAS. *The five-rayed Animalcules.*—This genus contains only one species; it is distinguished by its possessing a simple univalved five-sided lorica, with a central aperture, and in being free; sometimes it is developed in chains.

169. PENTASTERIAS *margaritacea.* *The pearl Pentasterias* has a granulated surface, and thick obtuse rays, as shewn at *fig.* 104. Size 1-540th. Found amongst conferva.

Genus XLVII. TESSARARTHRA. *The round-chain Animalcules* comprehend only one species (T. filiformis being now considered an Odontella); it is distinguished by a simple univalved smooth and globular lorica. While undergoing self-division it becomes chain-like, consisting of four or more members. The species is free; the internal organization is unknown, owing to its minuteness, and green matter within.

170. TESSARARTHRA *moniliformis* is green; two, three,

or four, are generally attached together in a line, as shewn in *fig.* 106. In *fig.* 105, two are seen, with two young ones growing between them. Size of each globe 1-1720th. Found amongst conferva.

Genus XLVIII. SPHAERASTRUM. *The round-star Animalcules* are characterized by their members being free, having a simple univalved smooth and turgid lorica, and by forming, during self-division, different shaped groups. A slight change of place or locomotion has been observed, but little or nothing of their organization is known, though Bory and Turpin have stated the existence of male seminal glands in S. quadrijuga.

171. SPHAERASTRUM *pictum. The globular Sphaerastrum* has oval green corpuscles, passing into spherical clusters, of the form of a mulberry. Size of berry 1-480th; of single member 1-1920th. Found with Micrasterias.

172. SPHAERASTRUM *quadrijugum. The four-rayed Sphaerastrum* has oblong green corpuscles, four being united into cubical masses, perforated at the middle. Size of berry 1-570th; of single member 1-1200th. Found with the former species.

Genus XLIX. XANTHIDIUM. *The double-bar Animalcules.*—The animalcules of this genus are characterized by being free (devoid of pedicle or stalk) and having a simple univalved lorica, of a globular form, surrounded with spines. They are found either single, in pairs, or groups of four. Ehrenberg thinks they may sometimes be developed in the form of a chain. The lorica is clear, like glass or parchment, covered with simple or branched bristles, like spines. No aperture has been discovered

in the lorica, nor has any locomotive organ been seen. The green mass of granules in the interior is considered as ova, and the glandular transparent globule observed in the centre of X. aculeatum as a testes. The only determinate and satisfactory character of the animal nature of this genus is its self-division.

All the species have been found in a fossil state in flints. In some sections, which I cut in 1834, they were very abundant, but until Ehrenberg's observations on them were known, they were not identified with recent species, and then considered as mere defects in the stone.

173. Xanthidium *hirsutum. The hairy Xanthidium* is green, of a globose form, and covered with simple hairs. They are found either solitary, or in pairs. Size 1-430th. Found in peat-water. A fossil specimen is shewn in *plate* xii., *fig.* 512.

174. Xanthidium *aculeatum. The spinous Xanthidium* only differs from the preceding in the lorica being covered with short-pointed spines, and occasionally as many as four being connected together. In the engraving, *plate* ii., *fig.* 109, a pair is shown highly magnified. In the middle of each globe is one or more large clear spots; these, as well as the green coloured internal mass, prevent our seeing whether it is further organized. In the fossil specimens, so abundant in many flints of the chalk formations, the internal parts have disappeared; and hence the lorica, with its spines, is seen diaphanous. Size of the single sphere 1-430th to 1-288th. Found with X. hirsutum.

175. Xanthidium *fasciculatum. The clustered-spine Xanthidium* has an oblong or globular green body, with long sharp spines, disposed in pairs or clusters. They are

found either solitary or in pairs. Size 1-570th to 1-280th. Found with the preceding; also fossil in flints.

176. Xanthidium *furcatum. The forked Xanthidium* has a globular green spinous lorica, and occurs either singly or in pairs, or at most four are connected together. A figure with a large glandular body within each is shown at *fig.* 110, which will convey to the reader the best idea of their form. According to Ehrenberg, some of these animalcules possess only one forked spine, the others being short and broad. Size 1-570th to 1-280th. The spines are usually half the length of the body.

177. Xanthidium ? *ramosum. The branched Xanthidium* has a globose lorica, covered with spines, trifid or branched at their extremities. The number of spines varies from six to twenty. They are found either single or in pairs. They are not figured by Dr. E. In *plate* xii., Mr. Bauer has drawn them at *fig.* 511 and 515. This species is only known in a fossil state; it occurs in the flints of most chalk formations. Dr. Ehrenberg thinks its true place is the genus Peridinium, as traces of a transverse groove have been observed. Size 1-1150th to 1-280th.

178. Xanthidium ? *difforme* is shewn at *fig.* 111, which represents a pair of these highly magnified; they have a turgid lorica, of a green colour. Found with Micrasterias. Fossil specimens are shewn in *plate* xii., *fig.* 513 and 514. Size 1-430th.

179. Xanthidium *crassipes. The thick blunt-spined Xanthidium* has a globose lorica, larger than the other species. There are two varieties: in one the thick blunt spines appear distinct; in the other, they often appear

together, resembling a fringe around the lorica. Found in flint. Size 1-280th.

180. XANTHIDIUM *tubiferum*. *The tubular spined Xanthidium* has long capitated spines. Found in flint. Size 1-400th.

Genus L. ARTHRODESMUS.—The animalcules comprised in this genus are distinguished by being free (no pedicle being present), and in having a simple univalved compressed lorica; they multiply by spontaneous self-division, in the form of tables, or compressed and articulated ribbons, each animalcule being contiguous to its neighbour. No locomotion or opening to the lorica has been seen. The chief animal character is self-division, and their close alliance, through Micrasterias and Euastrum, to Navicula, rather than to any known plant. The internal green colouring matter of their parchment-like lorica consists of minute homogeneous granules resembling ova, each cell-like lorica containing from one to three bright bodies, analogous to fecundating glands, which are often accompanied with crystalline vesicles, like polygastric stomachs.

181. ARTHRODESMUS *quadricaudatus*. *The four-tailed Arthrodesmus* has an oblong lorica; in consequence of incomplete self-division from four to eight are often connected together in a straight chain or polypi-like mass; when fully developed, the lorica at each end has two spines; these are wanting in young specimens. In some cases, though rarely, the central lorica has horns, and sometimes the terminal ones have a single horn protruding from their middle; the length of the horns vary; they are occasionally twice the length of the lorica. The green

matter can be discharged from an opening in the end of each lorica. Found with slimy and decaying portions of water plants, &c. Size 1-2180th to 1-1150th. Length of chain 1-570th.

182. Arthrodesmus *pectinatus. The comb Arthrodesmus* is green, fusiform, or oblong in shape; from four to eight are associated together, the exterior ones being seminulate. Size 1-1150th to 1-860th. Found with Micrasterias.

183. Arthrodesmus *acutus. The changing Arthrodesmus* is green and spindle-shaped, or oblong in form. In self-division, each adjoining one slips below the level of its neighbour, while the alternate ones remain. Size 1-570th. Found with oscillatoria, especially in the month of July.

184. Arthrodesmus *convergens. The embracing Arthrodesmus* is connected in pairs, as in *fig.* 112, or in four, as in *fig.* 113. In the latter, the two middle ones are produced from gemmae. Colour green. Size 1-570th.

185. Arthrodesmus *octocornis. The eight-horned Arthrodesmus* is green, slightly compressed, and quadrangular, each having four horns. Found with Navicula, &c. Size 1-1150th to 1-1200th.

186. Arthrodesmus *truncatus* is green, slightly compressed, companulate, and truncated. They occur in pairs, having the sides spinous. Found with Euglena sanguinea. Size, including spines, 1-480th.

Genus LI. Odontella. *The tooth-chained Animalcules* comprised in this small genus are unattached and free, having a simple univalved compressed lorica, and multiply by an incomplete spontaneous self-division, in the form of flat articulated ribbons or chains; each link of such chain-like bodies is composed of a single pair

united, which are connected with the next pair by two processes, a small space being left between them (see engraving *fig.* 108), and hence they differ from the genus Desmidium. The internal coloured granular matter is probably ova; and the three vesicles in O. filiformis, stomach cells and fecundating glands. In O. unidentata, the glandular body is very distinct from the digestive sacs.

187. ODONTELLA *desmidium* is shewn magnified at *fig.* 108; the space between the processes of each pair is distinct. Found amongst conferva. Size 1-1150th to 1-570th.

188. ODONTELLA ? *filiformis* (*Tessararthra filiformis*). *The filiform Odontella.—Figure* 107 exhibits a chain-like group magnified; the two slender processes connecting each pair leave a square space between them. Size of single member 1-2010th.

189. ODONTELLA ? *unidentata. The one-toothed Odontella* has oval binary corpuscles, often irregular; they are connected by a single tooth or process in the middle. Size of member 1-1440th.

Genus LII. MICRASTERIAS. *The little star Animalcules* are characterized by their members being free, by their having a simple compressed lorica, composed of one piece, and grouping themselves together in definite numbers, in the form of a flattened star. The latter generic character arises from incomplete self-division when they are young, like Gonium. Projecting organs of locomotion have not been observed, though slow change of place has been noticed. Numerous vesicles, analogous to polygastric digestive cells, are seen in several species; ova-like green granules are abundant; and Ehrenberg states he

has seen glandular bodies which periodically increase in size, and are analogous to the seminal glands of other Infusoria. The dispersion of the ova has been seen by Turpin and Meyen, though it was regarded by them as that of the fecundating matter of plants. Dr. E. appends the following observations to the genus :—

"1. The relations of number observed in Micrasterias appear to form a firm character of the species (as in Gonium pectorale).

"2. The relations of size are not always in a ratio with those of number; for we find small size with a large number, and great size with a small number of parts.

"3. Forms exhibiting equal relations of number to size otherwise distinguish themselves in secondary and less important points, as in a slender or thicker form of cell, long or short horns, &c. &c.; conditions varying in almost every individual.

"4. Of the numerous forms seen by me, all were two-pointed, none had one-pointed bodies. (No Pediastrum simplex).

"5. Regularity of form is the character of integrity from irregularity; no distinct species can be formed."

(*a*). *Bodies ray-like, in a circle, without a central cell.*

190. MICRASTERIAS *tetras. The four-rayed Micrasterias* is a star-like cluster, composed of four creatures connected together. (The margin is slightly emarginate.) Diameter of clusters 1-1150th to 1-2300th. Size of single body 1-2300th to 1-4600th.

(b). Bodies placed concentrically around one or two central cells (*), circle simple.

191. MICRASTERIAS *coronula.* *The five-fold Micrasterias* has quarternary bodies placed around a fifth, and having the margins variously excised; rare; found with oscillatoria, &c. Diameter of star 1-860th to 1-570th.

192. MICRASTERIAS *Napoleonis.* *Napoleon's Micrasterias* has six bodies, placed in a single series around two, and having their external edges variously notched (excised) or horned. This animalcule receives its name from Turpin, on account of its similarity of appearance to the star of the French legion of honour. This description agrees with T. 11, *f.* 3, from which I am induced to think there is some mistake in Ehrenberg's plate. *Figures* 117 and 118 represent two varieties. Size 1-1150th to 1-570th.

193. MICRASTERIAS *heptactis.* *The seven-rayed Micrasterias* (shewn at *fig.* 114) has seven bodies, placed in a simple series, with one or two in the middle. The margin is variously excised. The middle body is either round, or four or six-cornered; in the larger star-like clusters it is double. Size 1-1150th to 1-570th.

(**) Circle double.

194. MICRASTERIAS *Boryana.* *Bory's Micrasterias* has ten bodies in the external series, five in the internal, and one in the centre, as shewn in *fig.* 115 and 116. Each marginal body has an indentation, so that the star-like cluster appears like a toothed wheel; the teeth are short or long, but never truncated. In some specimens the

lorica is rough. Found, with other Bacillaria, in slime amongst conferva and oscillatoria. Size of star 1-1150th to 1-210th.

195. MICRASTERIAS *angulosa* has fifteen to sixteen bodies, arranged in a double series around a single one. The edges are truncated. Found with the preceding. Size 1-430th to 1-280th.

196. MICRASTERIAS *rotula. The wheel-like Micrasterias* varies in its mode of arrangement; it has usually eleven in the outer series, five in the second series, and one in the centre; they are often elongated and rayed, and the margins variously excised. Colour a superb yellowish-green. Diameter of star 1-800th to 1-400th.

(***) *Cirlce triple.*

197. MICRASTERIAS *tricyclia* has three series of bodies; fifteen are in the first or external one, eight or ten in the second, and four or five in the third or most internal one. The margins are variously excised. Found amongst floccose conferva. Diameter of star 1-720th to 1-210th.

(****) *Circles more than three.*

198. MICRASTERIAS *elliptica. The elongated Micrasterias* has four series of bodies, usually twenty-three in the outer one, and two in the middle. Found with the preceding. Size of star 1-280th to 1-210th.

Genus LIII. EUASTRUM. *The star-disked Animalcules* are distinguished by their members being free, inclosed in a simple compressed lorica, composed of only one piece, and by their adhering in pairs, which are disposed in the

form of a two-lobed disc or table. Whether a lobe can be regarded, separately from its companion, as a distinct organism, is not determined, but by cutting or destroying the one the other empties itself at the same time, although the lorica appears detached in the middle. No openings have been seen in the ends, as in Micrasterias, but it is probable such exist in the middle, where they are connected. The lorica is membranous, firm, colourless, and combustible; it contains the crystalline and contractile body of the animalcule, filled with green granules. Its propagation by self-division is peculiar and highly interesting. (See *fig.* 123.) The middle elongates, from which two new ones are formed, one uniting and forming the companion to one of the old ones, and the other producing the same with the remaining old one, when the newly-formed individuals separate, and two pair is the result. From this method of self-division, specimens, having unequal lobes, are produced, by some accidental rupture, before the new ones in the middle are fully developed. All the species are found among conferva.

199. Euastrum *rota. The wheel Euastrum* has a binary body, lenticular and disc-like in shape, as shewn in the engraving, *fig.* 121 and 122; the first being a flat, and the other an edge view. *Figure* 123 shews the mode of increase. The surface is smooth, the margin dentated or spinous, the number of teeth varies from twenty-eight to fifty-four; they are either obtuse or double-pointed; at the centre an opening appears to exist on each side, close to which, internally, are very minute moveable bodies, as in Closterium. The portions of the binary body are seldom symmetrical, one being larger than its companion.

Both change of place, and a circulating or oscillating motion, have been noticed. Size of disc 1-280th to 1-120th.

200. Euastrum *apiculatum. The spinous Euastrum* is lenticular and spinous. Size 1-140th.

201. Euastrum *crux melitensis* is lenticular and smooth, the margin is deeply indented, giving them the form of a Maltese cross, as seen at *fig.* 124. Their locomotion is periodical, and very difficult to be seen; old specimens have as many as forty marginal teeth, young ones only twelve. Size 1-570th to 1-1150th.

202. Euastrum *pecten. The comb-like Euastrum* somewhat resembles the next species, but is smooth, and each plate has five obtuse and emarginate lobes. Size 1-150th.

203. Euastrum *verrucosum* is shewn at *fig.* 125; the surface is rough and tuberculated. Ehrenberg's observations were made on green specimens, but Corda represents the contents of the body as brown. Size 1-280th.

204. Euastrum *ansatum. The pivot-like Euastrum,* when young, is oval, but when full-grown the pair becomes somewhat fusiform; the surface is smooth. Size 1-430th.

205. Euastrum *margaritiferum. The pearl Euastrum* is curiously granulated. (See *fig.* 126.) Spontaneous motion has been observed. Size 1-1440th to 1-280th.

206. Euastrum *botrytis. The berry-like Euastrum* is figured as augulosum by Ehrenberg. It resembles E. ansatum, but the surface is granulated. Size 1-576th.

207. Euastrum *integerrimum* is a binary elliptical body, with the surface and margin smooth. Size 1-480th to 1-600th.

Genus LIV. Microtheca. *The spinous-disc Animal-*

cules contain only one species; it is characterized by being free, and possessing a simple square compressed lorica, composed of one piece. In its organization it approaches that of Gallionella and Achnanthes.

208. MICROTHECA *octoceros. The eight-horned Microtheca* has a square transparent lorica, with spines, as shewn at *fig.* 119 and 120; the first being a front, and the latter a side view. It is of a golden colour, variegated; change of place has not been observed. "I received," says Ehrenberg, "in September, 1832, phosphorescent seawater from the harbour of Kiel. On the 23rd of October, I found therein this yellow creature, which appeared very similar to a specimen of Anuræa, which, together with yellow phosphorescent species of Peridinea, were living in the same water; but no direct evolution of light was observed from M. octoceros." Size 1-280th without the spines; with the spines 1-210th.

SECTION II.—NAVICULACEA.—(*Shells siliceous.*)

Genus LV. PYXIDICULA. *The round-box Animalcules.*—These Infusoria possess a simple bivalved siliceous lorica, of a globose form, which is marked by a furrow, where it easily separates into hemispheres. They are never gregarious, or cluster together. They are in organization closely allied to Gallionella. The ova is of a green yellowish colour.

Ehrenberg states, that in August, 1836, he found, in the flints of the neighbourhood of Berlin, numerous spherical bodies, of pretty equal size, the difference in whose

diameter varied from 1-240th 1-1150th of an inch. He considers it very probable that they belonged to the siliceous Infusoria, as siliceous spiculi belonging to the genera Spongilla, Xanthidium, and Pendinium, were met with in the same situation; whether they should be placed in the genus Pyxidicula is doubtful, as no furrow or division was observed on the shell.

209. PYXIDICULA *operculata.* *The box-like Pyxidicula* is shewn at *group* 127. The lorica is transparent and spherical; it contains yellowish-green ova-like matter. The upper figure is a view at right angles to that drawn on the left, shewing the furrow by which it separates; and the figure to the right is a hemisphere thus detached; in the lower figure a transparent glandular body is observable. No locomotion has been seen. I have found them abundant in autumn, among Navicula, at Hampstead. Diameter 1-1440th to 1-570th.

210. PYXIDICULA *globator.* *The ball Pyxidicula.*—I insert under this name the globular bodies found in the flints, as mentioned in the concluding remarks on the genus. The section of pebble containing the specimens from which Mr. Bauer's drawings in *plate* xii., *fig.* 506 to 510 were taken, was found on the Brighton beach; they are represented magnified 100 diameters.

Genus LVI. GALLIONELLA. *The box-chain Animalcules* are characterized as free, and possessing a simple bivalved siliceous lorica, of a cylindrical, globular, or discoid form. In consequence of an imperfect longitudinal self-division, they develope themselves in the form of a chain. The single members have one or two oblique furrows, with several openings in them. The lorica, when lying on its

face, resembles a coin. It is fragile and incombustible; that of G. ferruginea appears to be silicate of iron. A coloured and divided mass of ova (clustered like grapes) is seen internally, as also colourless vesicles or stomach-cells. Change of place has not been seen. They appear to me closely to resemble minute Algae, and are so considered by botanists. Nearly all the species are found in a fossil state and living; in the former they are exquisite objects for the microscope, under a deep power and proper illumination.

211. GALLIONELLA *lineata.* *The striped Gallionella* is cylindrical, the ends connecting them together being compressed, as shewn in the engraving, *fig.* 128, which is part of a chain, consisting of four individuals, highly magnified. The parts forming the chain are striated longitudinally; the ova are either yellow or green. It is found in sea-water, and a single chain sometimes measures three inches in length, and is composed of from 1200 to 4000 animalcules. Length of single individual 1-1400th to 1-430th.

212. GALLIONELLA *nummuloides.* *The spherical Gallionella* resembles the preceding species, but has its ends convex, so that a single animalcule is almost globular. They are smooth, and the ova is of a yellowish-green colour. Size 1-1700th to 1-860th.

213. GALLIONELLA *varians.* *The changing Gallionella* is cylindrical, with flat ends; when separate and short they rest upon the ends, and appear like a coin. In this position, under a good power, delicate radiating striae may be seen, as in *fig.* 131*; the ova are yellow or greenish. They are found both fossil and recent; the former are the principal part of the beds of white powder used for

polishing silver-plate. Found near the Upper Bann, Ireland. Size 1-2200th to 1-480th.

214. Gallionella *moniliformis. The bead-like Gallionella* is cylindrical, short; ends truncated cones; when single and viewed from the back, they appear octagonal. The lorica is smooth, and the ova of a greenish colour. Found in sea-water, and often confounded with G. lineata. Size 1-860th.

215. Gallionella *aurichalcea. The golden Gallionella* is cylindrical, the length full twice the diameter. It has either a single or two perforated rays contiguous at the middle; the ova are green, but when dried become of a golden-yellow colour. Thickness of chain 1-2300th to 1-1720th.

216. Gallionella *ferruginea. The rust-like Gallionella* has a slender oval lorica, convex at both ends; surface smooth. They are developed in the form of articulated threads, often agglutinated together, as if branched. In many, perhaps in all, chalybeate waters, and also in peat water, which contains a small proportion of iron, this curious little animalcule is to be found; it is of the colour of iron-rust, and in mineral springs in which it abounds is often taken for precipitated oxide of iron. It covers every thing under water, but forms so delicate and floccose a mass, that the least motion dissipates it. In the spring of the year, this mass is composed of very delicate pale yellow globules, which can be easily separated from each other. In their native abode they hang together in rows, like short chains, and produce an irregular gelatinous felt or floccose substance. About summer, or in autumn, they become developed into more

evidently articulated and stiff threads, of a somewhat larger diameter, but still form a complicated mass or web, and either from adhering to each other, or to delicate conferva, appear branched. In the young condition, when examined under shallow magnifiers, they resemble gelatine; but with a power of 300 diameters, the flexible granules are discoverable, and with dexterous management, the little chains forming the felt or floccose web can be made out. In summer, on the other hand, its structure can be observed much more easily and distinctly. Early in spring, the colour is that of a pale yellow ochre; but in summer, it is of an intense rusty red. *Plate* ii., *figures* 129 and 130 exhibit chains of these creatures differently magnified. Found both recent and fossil. Diameter 1-12000th.

217. GALLIONELLA *distans.* *The divided Gallionella* has short cylindrical corpuscles, plane and truncated at both sides. Two perforated striae, or furrows, are present, which are distant from each other. Found both living and fossil. Size of corpuscle 1-3456th.

218. GALLIONELLA *sulcata.* *The obliquely-striped Gallionella* has short cylindrical corpuscles, which are externally transversely sulcated, giving rise to a cellular appearance. See *group* 131, *plate* iii. Found only in a fossil state. Size 1-1150th to 1-860th.

Genus LVII. ACTINOCYCLUS. *The rayed-box Animalcules* are free, possess a simple bivalved siliceous lorica, have a cylindrical form, and their interior divided by numerous ray-like divisions. The self-division is imperfect, and they are developed in the form of chains. The genus contains two species, which are only met with

fossil. It is remarkable that of the whole of the fossil Infusoria, this genus is the only one which does not present living representatives. On reflection, we at once perceive that the central furrow of the sphere of Gallionella, which is pierced with holes, leads to an interior, having a rayed structure, which here shews distinct walls of separation for each hole or opening. The structure of the single, flat, dish-like body, is minutely cellular, and differs in this respect from Gallionella, though an approach may be seen in G. sulcata.

219. Actinocyclus *senarius*. *The six-celled Actinocyclus* has a cellular lorica, which is discoid in shape, and has six internal partitions. "The schistus of Oran," says Ehrenberg, "contains great quantities of little flat dishes of siliceous matter, which are very thin and (cellular) in structure; some are of greater size, and have larger cells than the others; it is doubtful whether these are or are not single bodies, each perfect in itself. If they are, the genus Arcella is their proper station. If two are seen connected together, so as to form a flat disc-like hollow box, the genus Gallionella is their situation, as G. sulcata presents the same structure. Along with these disc-like little plates others are seen, which are smaller in size, and whose mesh-like texture forms less regular spires, but in which, when under water, six walls or partitions, radiating from the centre, are seen, dividing the interior into six distinct chambers. The bodies evincing such formations are Actinocycli." *Group* 132 represents different views of them. Diameter 1-1150th to 1-720th.

220. Actinocyclus *octonarius*. *The eight-celled Actinocyclus* has a cellulose lorica, discoid in shape, and pro-

vided with eight internal partitions. Found fossil with the preceding; not so common. Size 1-576th.

Genus LVIII. Navicula. *The little ship Animalcules* derived their generic name from the resemblance in form of the many species to a weaver's shuttle: the English name here given is from the German. It comprehends those members of the family Bacillaria who are unattached by a pedicle (free), and have a simple bivalved or multivalved siliceous lorica. They occur single, or in pairs, but are never united in the form of a chain. The lorica of the Navicula is a closed, mostly four-sided, hard, and glass-like little case (*testula bivalvis*), which, in drying, often separates; when lightly pressed, it breaks or divides either into two or four longitudinal parts; sometimes the angles are provided with a short rib, distinctly furrowed, the lorica then separates into four equal parts; but in some cases the two rows of ribs are not visible, the two halves of the lorica being obliquely furrowed; it then separates into two parts. By heating the body upon platina-leaf, the animal is consumed, and the siliceous lorica left clear and free. The gelatinous and diaphanous body of these animalcules occupies the whole of the interior of the lorica, and has, near the centre, a sharply circumscribed colourless bright spot. In N. fulva, an organ of locomotion has been seen by Ehrenberg, which he describes as a fleshy, undivided, sole-like foot, proceeding from the central opening, and similar in appearance to the locomotive organ of snails. The side of the body where this foot-like process emanates is called the ventral surface of the animalcule. This foot not only answers the purpose of allowing it to creep, but the animalcule, when at rest, can draw objects to it, and push things away by it.

Whether the two openings on the ventral surface are mouths, and the two on the back apertures for respiration, is undecided; but the opening on the back, opposite the central ventral opening, is supposed by Ehrenberg a sexual one. No direct demonstration of the nutritive apparatus has yet been effected by using coloured food, though numerous scattered and colourless vesicles are to be seen within the bodies of several species, which indicate polygastric structure; but what Corda took for an alimentary canal (in Pharyngo glossa) was merely the dark central longitudinal furrow of the lorica. This genus is more complex in its structure than the two preceding; even the majority of botanists consider these beings as animals. The green, yellow, and brown colouring matter in their interior are supposed to be ova. It is in the form of broad plates or fillets, from two to four (8?) jointed together in the middle, occupy the interior of each lorica. These plates take the exact form of the interior of the shell, filling the cavities of the flutings, furrows, or striae. In many species, two or four round vesicles are seen, which, although they are not changeable in form, or contractile, yet are sometimes present and sometimes absent, and are probably analogous to small seminal glands. Many Navicula multiply by spontaneous self-division, in which case it is invariably longitudinal and dorsal, or lateral; the division taking place beneath the hard epidermis, as in Gallionella and Achnanthes, and the lorica separating afterwards. It is seldom in this genus that a second self-division commences before the first is complete and separates; indeed, species, whose individuals separate into four, should be placed in Fragilaria.

Fourteen of the living forms of Navicula have been

found in the fossil condition ; and ten fossil species have no living representative. They are found only in the most recently-formed strata and tertiary formations ; none have been found in the chalk.

(*a*). *Lorica smooth within—ribless Naviculæ.*

221. Navicula *Phoenicenteron* (*Cymbella, Agardh.*)—*The reddish Navicula* has a smooth siliceous lorica, of an elongated lanceolate form, as shewn in the engraving, *plate* iii., *group* 139 ; longitudinal striae are rare. The central opening is oblong, its greatest diameter being transverse. It is very motile. Found in ponds at Hampstead; and fossil at Santa Fiora, in Tuscany. Length 1-400th to 1-140th.

222. Navicula *gracilis* (*Vibrio tripunct,* M.) *The slender Navicula* is smooth; the central opening round, and the ends truncated. It occurs abundantly with oscillatoria, and is found fossil at Cassel, &c. Length 1-1500th to 1-560th.

223. Navicula ? *pellucida. The furrowed Navicula* has a slender lorica, as shewn at *fig.* 140, which represents a group of them ; and above is an outline section, taken across the middle, to show the position of the central furrow in each side; moveable. Found with the preceding. Length 1-300th to 1-140th.

224. Navicula *acus. The needle-shaped Navicula,* shewn at *group* 147, is smooth, straight, and pointed at both ends. The ova grains are in the middle, and of a yellow brown colour. This species resembles Closterium setaceum, and some of the Fragilaria or Synedra, when separated. Length 1-430th to 1-280th.

225. Navicula *umbonata.* *The knot-bearing Navicula* is straight and smooth; the side is constricted near the middle, and hence the ends appear enlarged, from which it derives its specific name. Found both in salt and fresh water; also fossil. Length 1-430th to 1-240th.

226. Navicula *fulva.* *The yellow Navicula* has a smooth, broad, lanceolate lorica; near the ends, the shell is slightly produced in the form of a rostrum. The ova are yellowish, brown, or green; the medial aperture round. Found with oscillatoria in turbid water; also young specimens, fossil, in Bohemia. Length 1-1150th to 1-180th.

227. Navicula *amphisbaena* has a smooth lorica of the form shewn at *group* 141; the right hand figure is a side view. The central opening is round, and the ova are of a golden-yellow colour. Ehrenberg remarks, that the vibratile process seen by Bory St. Vincent was in fact the locomotive organ, the action of which is readily seen, though it protrudes but a very little beyond the lorica. In the specimens figured, transverse self-division of the ova has commenced, and two small gland-like spots are visible. Length 1-1700th to 1-240th.

228. Navicula *platistoma.* *The broad-mouthed Navicula* has a smooth lorica of the form shewn at *fig.* 142. The central opening is lengthened transversely. Found with oscillatoria. Length 1-1100th to 1-240th.

229. Navicula *nodosa.* *The nodose Navicula* is smooth, has a linear lorica, with three lateral undulations, or knots, at the middle, and the extremities constricted into the form of an obtuse beak, as seen at *fig.* 143; central opening round. Length 1-430th.

230. NAVICULA *trochus*. *The fly-wheel Navicula* is smooth; the lorica is enlarged at the centre and constricted at the ends. The central opening is round, and the lorica has several longitudinal striae. Found fossil, in Sweden. Length 1-860th.

231. NAVICULA *follis*. *The tube-like Navicula* is smooth, and has a short depressed lorica, swelled at the middle, but no longitudinal striae. Found fossil, at Santa Fiora, in Tuscany. Size 1-2300th.

232. NAVICULA? *trinodis*. *The three-bellied Navicula* is smooth, has a linear elongated lorica, having a slight turgidity at the middle of one side. Found fossil, at Degernfors, in Sweden, &c. Size 1-860th to 1-480th.

233. NAVICULA *cari*. *The carus Navicula* is smooth, and has a slender lanceolate lorica, acute at all sides. Found fossil, at Cassel. Size 1-1150th.

234. NAVICULA? *quadricostata*. *The four-ribbed Navicula* has a slender ovato-oblong lorica, with four longitudinal striae or ribs, and is truncated at both ends. Found in mineral water, at Carlsbad. Size 1-1720th to 1-860th.

235. NAVICULA *Baltica*. *The Baltic Navicula* is smooth, and has a sigmoid-shaped lorica, straight and linear at the middle, and obtuse at the ends, as shewn at *fig.* 144. The interior is of a yellow golden colour, and the central opening appears small and round; no motion has been seen. Found in phosphorescent sea-water. Length 1-70th.

236. NAVICULA *hippocampus*. *The little sea-horse Navicula* is smooth; lorica sigmoid, lanceolate. (See *group* 145.) Sometimes it has delicate longitudinal striae. Found in fresh and salt water. Size 1-90th to 1-70th.

237. NAVICULA *sigma* is smooth, has a lanceolate sig-

moid-shaped lorica, devoid of striae; when viewed edgeways, it is straight. (See *group* 146). It often contains motile granules. The ova are of a golden-yellow; colourless digestive cells are often visible. Found in fresh and salt water. Size 1-210th to 1-140th.

238. Navicula *scalpum*. *The knife Navicula* resembles the preceding, but smaller. Found in sea-water; and fossil in the Schistus of Berlin. Length 1-430th to 1-290th.

239. Navicula *curvula*. *The crooked Navicula* is moveable, and has a narrow linear sublanceolate sigmoid lorica, devoid of longitudinal striae or rays. Found amongst oscillatoria. Size 1-430th.

240. Navicula *arcus*. *The bow Navicula* has a narrow, linear, curved, and smooth lorica, inflexed and umbilicated at the centre. Found in mineral water. Length 1-6000th to 1-570th.

(*b*). *Transversely striated—internally ribbed Naviculæ.*

Surirella.

241. Navicula *sigmoidea* is striated. *Group* 148 shews to the left a specimen undergoing longitudinal self-division, and the figure on the right is a side view. The relation of the length to the number of stripes is as follows:—Those individuals which were 1-720th long had ten stripes; 1-570th, fourteen; 1-480th, fifteen; 1-360th, twenty; 1-280th, twenty-seven; 1-140th, fifty-four; 1-120th, sixty; 1-70th, one hundred and eight; 1-48th, one hundred and sixty; 1-36th, two hundred and sixteen.

242. Navicula *viridis*. *The green Navicula* is striated; has a straight lorica, truncated at the ends. *Fig.* 133 and 134 exhibit views of the shells empty, as found fossil;

fig. 135 and 136, recent species, the arrows indicating the direction of the current produced. This species has fifteen striae (*cellules*) internally, in every hundredth part of a line of its length. In the interior, numerous changeable vesicles are seen, connected together by means of an irritable gelatinous matter, which is as clear as crystal, and from whose motion these stomach-cells often appear to tremble. Ehrenberg has noticed moveable dark spots near the extremity of some specimens, similar to what is seen in Closterium, &c. The progress of longitudinal self-division may often be observed beneath the siliceous lorica. The six openings of the lorica are easily seen, three being upon the upper surface and three on the lower. The lorica near the central opening being depressed, the aperture appears eccentric, in respect to the medial line. Found at Hampstead, and fossil in Bohemia, Sweden, &c. Length 1-1150th to 1-70th.

243. NAVICULA *macilenta* is striated, has a straight slender lorica, truncated on one side, and rounded on the other. Twenty-three transverse striae are seen in 1-100th of a line. Found fossil. Size 1-140th.

244. NAVICULA *viridula. The greenish Navicula* has a straight lanceolate lorica, slender and truncated at one side, and attenuated and obtuse on the other. Thirteen or fifteen striae are seen in 1-100th of a line. Found living and fossil. Size 1-3000th to 1-280th.

245. NAVICULA *inequalis. The unequal Navicula* is striated and unequally convex. (See *group* 154.) The clusters of ova are of a yellowish colour. In 1-100th of a line are ten or eleven striae. This species forms the passage to the genus Eunotia. Found, living, at Til-

bury Fort; fossil at Santa Fiora. Length 1-430th to 1-120th.

246. NAVICULA *gibba*. *The gibbous Navicula* is striated, has a straight lorica, swelled at the middle, and gibbous. Nine striae in 1-100th of a line. Found, living, in brackish water, at Gravesend, and fossil in the Isle of France. Length 1-430th to 1-120th.

247. NAVICULA (?) *crux*. *The cross-like Navicula* is striated, has a short lorica, swelled very much laterally at the middle, so as to appear like a cross. Seventeen striae in 1-100th of a line. Rare: found only fossil. Length 1-1150th.

248. NAVICULA (?) *glans*. *The acorn-like Navicula* is striated, has a short lorica, swelled at the centre in the form of an acorn. Two or three striae in 1-100th of a line. Found only fossil. Length 1-1150th to 1-576th.

249. NAVICULA *capitata*. *The knobbed Navicula* is striated, has a short ovato-lanceolate lorica, extremities constricted and obtuse. Ten transverse striae in 1-100th of a line. Length 1-1150th to 1-576th.

250. NAVICULA *dicephala*. *The double-headed Navicula* is striated, has a bright lorica, constricted and obtuse at both ends. Nineteen transverse striae in 1-100th of a line. Found fossil at Degernfort, in Sweden. Length 1-860th to 1-480th.

251. NAVICULA *lanceolata*. *The lancet-shaped Navicula* is striated, has a lanceolate elongated lorica, gradually becoming acute at the ends. Thirteen transverse striae in 1-100th of a line. Length 1-1150th to 1-280th.

252. NAVICULA (?) *librile*. *The balance Navicula* is striated, has an elongated lorica, undulated at the sides,

the middle slightly constricted, and extremities sub-acute. (See *group* 155.) Eight transverse striae in 1-100th of a line. Found, living, at Gravesend, and fossil at Santa Fiora. Length 1-860th to 1-100th.

253. Navicula (?) *splendida. The golden Navicula.*— This beautiful and scarce species is striated, and has an ovato-oblong lorica, as shewn in *fig.* 150, 151, and 152; the first is an oblique view the second a side view, and the third a front (end) view of a dead specimen. Two transverse striae in 1-100th of a line. "In June, 1837," observes Ehrenberg, "was the last time I saw this species. The specimens resembled Turpin's Surirella striatella, found in the sea at Havre, but were, nevertheless, distinguishable by their form and stripes. I saw them move very often. The plates of the ova clusters are toothed, and of a golden yellow colour." Length 1-210th to 1-100th.

254. Navicula (?) *bifrons. The two-beaked Navicula* is striated, resembles the preceding, but both ends of the lateral surface are acute, and the ventral truncated. Three-and-half striae in 1-100th of a line. Found amongst oscillatoria, and fossil in the Isle of France. Length 1-210th to 1-100th.

255. Navicula (?) *striatula. The striated Navicula* is striated, and has an oval lorica, which is taper on its lateral surface, and elliptical, or cuneiform, on its ventral one, as seen in *fig.* 137 and 138. Thirteen striae in 1-100th of a line. This little creature was discovered by Dr. Suriray in August, 1826, and preserved alive for eighteen months. The body is very transparent and colourless, and the movement, which is slow, is only observed in those forms

which are stretched out, by the clusters of ova within them. Found at Havre, alive, and fossil in Bohemia. Length 1-3450th to 1-60th.

256. Navicula (?) *undulata*. *The wave Navicula* is striated, its lorica is elliptical on the lateral surface, linear and truncated on the belly, each surface having four flexures, as shewn in the oblique view, *fig.* 149. Found amongst oscillatoria. Length 1-210th.

257. Navicula *constricta*. *The constricted Navicula* is striated, has an oblong lorica, slightly constricted at the middle of the ventral surface. The extremities are obtusely truncated. Three to four striae in 1-100th of a line. Found with N. splendida. Length 1-210th.

258. Navicula (?) *amphora*. *The tun-like Navicula* is striated, has an ovate unequal lorica, swelled at one side, and plane on the other. (See *fig.* 153.) There are nine delicate transverse striae in 1-100th of a line. This species is easily confounded with Cocconema cistula, when the latter is without a stalk; but the Nav. amphora is so delicately striated that Ehrenberg considered it for some time smooth, whilst Coc. cistula is very distinctly striated. Length 1-160th to 1-120th.

259. Navicula *lineolata*. *The lined Navicula* resembles the preceding, but its delicate striae are longitudinal. It is compressed on the ventral surface, and convex on the back. Size 1-280th to 1-140th.

Genus LIX. Eunotia. *The beautiful little ship Animalcules* are free (unattached by a pedicle), inclosed in a siliceous lorica, of the form of a prism, composed of one, two, or more pieces or valves. The lower or ventral side is flat, the other or dorsal side is convex, and often den-

tated; one of them has four openings, two at each end. Their mode of propagation is simple and complete; hence they never occur in chain-like clusters, but are always single or in pairs. Thirteen species are known—three living forms, and ten fossil. The first are closely allied to the genus Navicula, but they have no central opening, and from the peculiar shape of the lorica, like the Coccus, they can crawl about Algae, and indeed are parasitical upon them.

260. EUNOTIA *turgida. The swollen Eunotia* has a semi-lanceolate lorica, truncated at the ends, and striated; these striae are so close together that eight are contained in the space of the 1-100th part of a line. A longitudinal furrow runs along the middle of each side; these are carcely visible in living specimens, owing to the colour of the body. In *group* 157, three of them are shewn crawling upon a piece of Conferva rivularis. *Fig.* 158 is a specimen undergoing longitudinal self-division, as seen under a magnifying power of 600 times. *Fig.* 160 is the lower or ventral valve of the lorica separated, and shewing the openings at the ends and striae; and *fig.* 159 a side view of it. *Fig.* 161 is an end view. Found upon vaucheria and conferva. Length 1-1150th to 1-240th.

261. EUNOTIA *Westermanni. Westermann's Eunotia* is striated, and has a semi-lanceolate oval lorica, with ten striae in each 1-100th of a line. It is of a rich ochre colour. In *group* 157 those figures marked with a cross represent this species on a piece of conferva. Found with the preceding. Length 1-1150th to 1-480th.

262. EUNOTIA *zebra. The zebra Eunotia* is striated, and of a semi-lanceolate oblong form, with five transverse

striae in 1-100th of a line. In the living state the striae are seen with difficulty, but easily when the lorica is empty. Found, living, among oscillatoria; fossil at Santa Fiora. Length 1-1840th to 1-570th.

263. Eunotia *granulata. The granulated Eunotia* has only been observed in a fossil state; it is striated, and has a semi-lanceolate elongated lorica, granulated upon the surface, as seen at *fig.* 165. Striae five in 1-100th of a line. (Franzensbad.) Length 1-240th to 1-140th.

264. Eunotia *faba. The beam-like Eunotia* is striated, and has a semi-oval-shaped lorica, of the form of a beam. Nine striae in 1-100th of a line. Found fossil in Sweden. Length 1-1150th to 1-570th.

265. Eunotia *arcus. The bow-shaped Eunotia* is striated, and has its lorica constricted, near the ends, in the form of a bow. Eleven striae in 1-100th of a line. Found fossil in Sweden. Length 1-480th to 1-280th.

266. Eunotia *diodon. The bidentated Eunotia* is striated, plane on the ventral side, and obtusely bidentated at the middle of the back. Found fossil in Sweden, &c. Length 1-570th.

This species and the five following closely resemble each other, the only difference being in the number of undulations or dentations on the dorsal surface, and the name is derived from the prominences or dentations thus produced; they are all fossil. *Group* 164 represents a side and under view of E. triodon.

267. Eunotia *triodon*, three dentations. Length 1-570th. (Sweden.)

268. Eunotia *tetraodon*, four dentations. Length 1-570th. (Finland.)

269. Eunotia *pentodon,* five dentations. Length 1-570th. Fossil, at Bergmehl.

270. Eunotia *diadema,* six dentations. Length 1-238th. (Finland.)

271. Eunotia *serra,* twelve or thirteen dentations. Length 1-280th. (Sweden.)

Genus LX. Cocconeïs.—*The shield little ship Animalcules.*—These Bacillaria are free, their siliceous lorica is bivalve and prismatical, or somewhat hemispherical in shape, with two apertures, one in the middle of each piece. They are never developed in the form of a chain, and their propagation by self-division, or gemmules, is doubtful. They never cluster, and are mostly striated; the transverse striae appear to be internal flutings like ribs. The lorica is composed of two lateral pieces, joined together at a central furrow, somewhat resembling the keel of a boat, the under surface being flat, the upper somewhat arched. A foot-like process has been seen projecting out of the central opening, on the under surface. The internal matter, or ova, is green or yellow, and often appears to be formed in two plate-like masses. Though the actual motion has not been observed, change of place appears to ensue.

272. Cocconeïs *scutellum* *The shield Cocconeïs* has a convex elliptical lorica, externally granulated, with transverse striae internally. They are found upon the sea-weed Ceramium diaphanum, a portion of which, with their Infusoria, is shewn at *group* 162, and a single specimen at *fig.* 163. Fossil in the Schist (Polirschiefer) of Cassel. Length 1-1150th to 1-240th.

273. Cocconeïs *undulata.* *The wave Cocconeïs* has the

same locality as the preceding, and only differs from it in the markings of its lorica, which are very delicate concentric undulating lines. Length 1-432nd.

274. COCCONEÏS *placentula. The cake Cocconeïs* has a smooth elliptical flat lorica, with an abrupt margin. Found upon vaucheria and lemna. Length 1-1440th.

275. COCCONEÏS *pediculus. The parasitical Cocconeïs* infests the Naviculæ; it has an oval, convex, and smooth lorica. Length 1-2200th.

276. COCCONEÏS (?) *finnica* has an oval lorica, slightly convex, and smooth externally; internally it is striated. Found fossil in Finland. Length 1-570th.

277. COCCONEÏS (?) *clypeus. The round Cocconeïs* is slightly curved, externally it is smooth, but striated within. Found fossil, in siliceous paste (Kiesselguhr) in Franzensbad and Bohemia. Original drawings of this elegant fossil Infusoria are shewn in *plate* xii., *fig.* 516 to 518. It has recently been placed in a new genus, under the name Campilodiscus. Diameter of disc 1-430th to 1-240th.

Genus LXI. BACILLARIA. *The zig-zag or true stick Animalcules* are unattached to a pedicle, have a simple bivalved or multivalved siliceous lorica, in the form of a many-sided prism. In consequence of the perfect self-division of the lorica, but incomplete separation of the body, they form gaping or zig-zag chains, as shewn in *fig.* 166 to 170; even when thus connected together they are motile. "The organs of locomotion," says Ehrenberg, "are soft peg-like processes, projecting from a longitudinal cleft. In B. tabellaris, transparent polygastric vesicles have been seen. Two openings are visible at the end of the lorica; hitherto the nutritive organs have not been

demonstrated by artificial means. At one time it was supposed these animalcules had no mouth, but were nourished by absorption. The self-division is always longitudinal and dorsal, so that the surfaces which hang together are those of the sides. A small deflection and locomotion of the chains is observable in the first water species, but is more remarkable in the marine varieties of B. paradoxa, which, when separated, move quickly, like Navicula. The name Bacillaria was first given to them by G. Malin, and from botanists take the names of Diatoma, Conferva, and Oscillatoria. They form part of the genus Vibrio of Müller."

278. Bacillaria *paradoxa* (*Vibrio paxillifer*, M.) *The paradoxical Bacillaria* has a straight slender striated lorica, often fifteen times longer than it is broad. Nine striae occur in every 1-100th of a line. They are of a yellow-ochre colour, and their locomotion is distinct. In consequence of incomplete self-division they adhere side by side, and the band-like clusters thus formed are either straight, wavy, or zig-zag, according as they slide one upon another. In the engraving, *group* 167 is a polypi-like cluster, and *fig.* 166 a front and side view of a single specimen. Found upon sea-weed. Length 1-1150th to 1-240th.

279. Bacillaria *vulgaris*. *The common Bacillaria*, or the *Diatoma flocculosum* of botanists, has a straight lorica, three or four times longer than it is broad. It has thirteen transverse striae in every 1-100th of a line of its length. *Fig.* 168 is the dorsal view of part of a group of four specimens; viewed sideways, they resemble a spindle. Found both in fresh and salt water: in the Rhone, it covers over Conferva glomerata, in the form of a thick

felt. It is found in a fossil state in the Isle of France and Bilen. Length of single specimens 1-570th to 1-430th.

280. Bacillaria *pectanalis. The comb-like Bacillaria,* or the *Diatoma tenue* of Agardh's *Algae,* has a striated slender lorica, very often three to six times longer than it is broad; it is of a brownish-yellow colour. Nine striae in 1-100th of a line. Found both in fresh and sea waters. Length of single rods 1-3240th to 1-430th.

281. Bacillaria *elongata. The elongated Bacillaria* has a slender striated lorica, slightly attenuated in the middle, as seen in *group* 169. Twelve transverse striae in 1-100th of a line. Length of single specimen 1-1150th to 1-240th.

282. Bacillaria *cuneata. The wedge-like Bacillaria* is striated, and of the form shewn in the engraving, *fig.* 170. Found in fresh water. Length 1-1150th to 1-1200th.

283. Bacillaria *Cleopatrae. Cleopatra's Bacillaria* has an oblong lorica, destitute of striae. This species is of a golden-yellow colour, and was found by Ehrenberg near the ruins of the Baths of Cleopatra. Length 1-570th to 1-480th.

284. Bacillaria (?) *tabellaris. The tablet Bacillaria* has a narrow smooth lorica, slightly enlarged at the middle; when adhering together they form square plates of variable lengths; ova yellowish, and divided. Found upon Conferva glomerata. Length of single rod 1-1150th to 1-960th.

285. Bacillaria *flocculosa. The floccose Bacillaria* has a smooth lorica, almost square, and not enlarged at the middle. Length 1-1440th.

286. Bacillaria *seriata. The spotted Bacillaria* has a slender straight lorica, eight or nine times longer than it is broad; the ova grains are divided into four or five masses. Found amongst conferva. Length 1-360th.

287. Bacillaria *Ptolemaei. Ptolemy's Bacillaria* is very small and smooth (?) length, twice or thrice its breadth. Colour pale. Found in Alexandria. Length 1-3600th.

Genus LXII. Tessella. *The flat-chain Animalcules* are free, for though often entangled together, they are never attached; they are covered with a simple bivalved or multivalved siliceous lorica, prismatic in shape, and (dilated and compressed) into the form of a table. In consequence of perfect self-division of the lorica, and imperfect division of the body, they are developed in the form of gaping chains or zig-zag polypi clusters. The articulations are mobile, and in the form of a plate (not wand or rod-shaped). In organization they stand between Achnanthes and Bacillaria. No opening in the lorica has been distinctly seen; longitudinal clefts are present, and essentially characterize this genus. The ova cluster has numerous lappets, and looks like a great number of roundish yellowish-green coloured spots, which are not the ova themselves, but the structure containing them.

288. Tessella *catena. The striated Tessella* has a plate-like lorica, often broader than it is long; it has from four to twenty-four longitudinal series of transverse striae. (See *fig.* 180, 181, and 182.) Found amongst Ceramia and other sea-weeds. Length of table (that is, breadth of the bands) 1-570th to 1-240th.

289. Tessella *arcuata. The smooth Tessella* is nearly

square, and marked with continuous longitudinal lines, but not with transverse striae. Found upon Ceramium rubrum. Length 1-430th.

290. Tessella *interrupta* is nearly square, with the longitudinal lines interrupted in the middle; striae none. Length of table 1-570th.

Genus LXIII. Fragilaria. *The fragile little wand Animalcules* comprehend free Infusoria, inclosed in a simple bivalved or multivalved siliceous lorica, prismatic in form, resembling Navicula. Self-division, both of lorica and body, incomplete; hence they are in the form of band-like chains, and are very fragile. In most species each end of the lorica has two openings; these are in the same plane, so that the surfaces upon which the chain rests may be considered lateral, and the self-division will then be dorsal. The whole chain sometimes rises in the water and turns itself round, while simple specimens have a progressive movement. In F. grandis, turgidula, scalaris, diopthalma, and pectinalis, polygastric stomach-cells are seen. The ova clusters are green or yellowish, when young, but reddish-brown when old. The most evident manner of propagation is dorsal self-division. In many species the creature continues to grow both during and after self-division, but in F. striatula increase of size ceases after division.

291. Fragilaria *grandis*. *The great Fragilaria* is striated, lanceolate in form, the ends obtuse laterally. As many as thirty often cluster in a single band. *Fig.* 171 is a band of seven; in four of them the ova protrudes, a portion of the lorica being cut off. In 1-100th of a line there are eleven striae. Found in fresh water. Bands

consist of two to thirty wands. Length of single wands, or rods, 1-570th to 1-120th.

292. FRAGILARIA *rhabdosoma* (*Vibrio tripentatus*, M.) *The common Fragilaria* is smooth, slender, and from five to twenty times longer than it is broad. The extremities of the lateral surface are needle-shaped. In some chains, the specimens are united together firmly; in others, the bands easily drop to pieces; the portions afterwards creep in a live manner. They may easily be mistaken for Synedra and Navicula; but the number and position of the openings are the distinguishing marks. *Group* 174 are separate specimens, and *fig.* 173 a band of them. Found, living, in fresh water, and fossil in the Polirschiefer of Cassel. Length 1-570th to 1-200th.

293. FRAGILARIA *turgidula.* *The broad Fragilaria* is striated, and from two to three times longer than it is broad, as seen in *group* 172. In 1-100th of a line, there are nine striae. Length 1-1720th to 1-570th.

294. FRAGILARIA *multipunctata.* *The punctated Fragilaria* is smooth, has slender corpuscles, and is eight to sixteen times longer than broad; ova of a yellow golden colour, and multipartite. Found amongst conferva. Length 1-570th to 1-280th.

295. FRAGILARIA *bipunctata* is probably synonymous with *rhabdosoma;* it is smooth, and four to five times longer than it is broad. The ova are of a golden-yellow colour, and contracted into the form of two rounded spots. Found near Mount Sinai. Length 1-1200th to 1-760th.

296. FRAGILARIA *angusta.* *The narrow Fragilaria* is smooth, and five to six times longer than broad; ova of

a fallow or greenish hue. Breadth of band 1-480th to 1-570th.

297. FRAGILARIA *scalaris*. *The ladder-like Fragilaria* is smooth, and seven to eight times longer than broad; ova of a fallow hue. Breadth of band 1-860th to 1-570th.

298. FRAGILARIA *diopthalma*. *The two-eyed Fragilaria* is smooth, and three or four times longer than broad; ova of a yellow golden colour, disposed in two portions. Length 1-960th to 1-1150th.

299. FRAGILARIA *pectinalis*. *The comb-like Fragilaria* is striated, and two to four times longer than broad. This species is swelled and lanceolate upon the lateral surface, and has eight striae in 1-100th of a line; ova of a yellow hue. In the living state, the striae are very indistinct. *Group* 176 exhibits a band of five specimens, with indications of stomach-cells, and the side view of a single one. Found both recent and fossil; the latter in the Isle of France, and in Bergmehl, in Sweden. Length 1-2200th to 1-430th.

Genus LXIV. MERIDION. *The fan little wand Animalcules.*—The characters of this small genus differ from the preceding only in the mode of aggregating during self-division, which is in the form of a volute or spiral, occasioned by one end being broader than the other. In organization, they are closely allied to Navicula, except that they have two openings at the broad end only. Ehrenberg says the ova cluster is four-leaved, and numerous stomach-cells are seen; single wands of both these species are difficult to distinguish from species of Gomphonema; but the latter, it should be remembered, have a middle opening, as well as two anteriorly.

300. Meridion *vernale* (*Enchinella*, Greville). *The spring Meridion* has a striated wedged-shaped lorica, truncated and dentated at the anterior extremity. *Fig.* 177 is a spiral cluster; these sometimes appear circular. *Fig.* 178 is a cluster separating, in which some are seen from the side. Length of single specimen, or wand, 1-1150th to 1-240th.

301. Meridion ? *panduriforme* (*Exilaria, Berlin Trans.*) *The fiddle-like Meridion* has a sinuous, wedge-shaped lorica, of the form of a violin. Length 1-430th.

Section III.—*Attached.*—Echinellea.

Genus LXV. Isthmia.—The Infusoria belonging to this genus are attached by one of their extremities to sea-weed, &c.; they are developed in the form of a chain, have a simple siliceous lorica, broader than it is long, articulated to each other by a short neck-like process—hence their name, Isthmia: this part is sometimes called the foot, and near which a single opening in the lorica is observable; the lorica is not destroyed by heat or acids. In the interior is a floccose substance, analogous to ova. Self-division ensues along the short axis of the body: hence it is properly longitudinal, though it appears transverse.

302. Isthmia *obliquata* (*Diatoma obliquetum*, Lyngbye). *The ribbed Isthmia* is nearly square, with cellular, middle, and transverse striated ends. Found in sea Algae. Size of single animalcule 1-90th.

303. Isthmia *enervis*. *The smooth Isthmia* resembles

in form the preceding, but it is elongated. Its trapezoid form and reticulation, in place of striae, are seen in *plate* iv., *fig.* 183; they are represented attached to sea-weed (Callithaminum), to which they mostly attach themselves. As opaque objects, they exhibit great beauty under the microscope; the different portions, which appear like reticulations, are in this way shewn in relief. Size 1-60th.

Genus LXVI. SYNEDRA. *The yard or ell-measure Animalcules.*—The members of this genus, when young, are attached by one of their extremities; but at a later period are often free. They are longer than they are broad; are destitute of a distinct foot or neck-like process, or which, at most, is rudimentary. Their lorica is simple (smooth or striated), siliceous, and in the form of a wand or rod; (prism-shaped) openings exist at their ends, but none in the middle; the cluster of ova is sometimes divided into from two to four leaf-like plates, or into purses or lappets; digestive cells have not been observed.

304. SYNEDRA *ulna* (*Vibrio bipunctatus*, M.) *The common Synedra* is striated, truncated laterally; as age advances the lateral ends become dilated; upon the broad side of the dilated end are seen three obtuse teeth, and two openings between them. These creatures often occur in vast numbers, appearing as a white incrustation, covering the stones on the banks of rivers in summer. Dr. Lancaster has noticed this in the Annan, Dumfriesshire: wherever a mass of gravel was exposed to the air, the surface of the stones appeared thus covered. With a pocket magnifier, they resembled acicular crystals; using a deeper power, and examining the wet stones on the edge

of the water, they were mostly arranged in a stellate form, resting upon filaments of conferva. Size 1-100th long, 1-2000th broad. Dr. L. says, the lorica of those from the Annan is not striated, nor are their ends dilated.—(*Proc. Lin. Soc.*) Sometimes they attach themselves to Vorticella, as shewn in *fig.* 184, which represents several of them thus situated; that marked by a cross is itself infected by the growth of Podosphenia upon it; so that we have here an example of one parasite growing upon another. Found both in fresh and brackish water. Size 1-280th to 1-100th.

305. SYNEDRA *capitata. The broad-headed Synedra* is striated, straight, and of the form shewn at *group* 185*, which exhibits a front and side view; ova yellowish-green. Found both living and fossil. Length 1-120th.

306. SYNEDRA *Gallionii* (*Diatoma fasci*, Agardh).—*Gallion's Synedra* is smooth, wand-like, and attenuated laterally. The ova are in round clusters, arranged along the lorica. It inhabits the sea. Length 1-120th.

307. SYNEDRA *fasciculata. The bundle-like Synedra* is smooth, attenuated near the extremities, and slightly acute on all sides. Found attached to conferva. Length 1-860th.

308. SYNEDRA *lunaris. The sickle-shaped Synedra* is smooth, curved, and associated together upon conferva, as shewn in *group* 185. Length 1-432nd.

309. SYNEDRA *bilunaris. The doubly-bent Synedra* is smooth, and resembles two lunate or crescent-shaped bodies attached end to end. Found upon conferva. Length 1-570th.

Genus LXVII. PODOSPHENIA. *The wedge little plate*

Animalcules.—Infusoria with a simple, siliceous, wedge-shaped (cuneiform) lorica, attached, when young, (by a little pedicle, or none,) but often becoming free at a later period; longer than broad. The bivalved lorica has two openings at its broad anterior end; ova yellowish-green. When young, they are scattered, but united into one or two masses (often star-shaped) when old. According to Ehrenberg, spontaneous longitudinal self-division is common. Fragments of Meridion and Echinella are liable to be mistaken for this genus.

310. PODOSPHENIA *gracilis. The slender Podosphenia* has a smooth wedge-shaped lorica, as shewn at *fig.* 186, which is a group of them attached to a thread-like filament, from which they are often mistaken for Echinella; but in this case the filament is not part of the creature, but merely the substance to which it has adhered. In this way it often covers Algae, Vorticella, Sertularia, &c. At the lower part of the group, towards the right side, is represented a side view of one laying across two others, shewn in front view; in the latter, delicate longitudinal striae are visible, and in the former the upper part of the lorica is rounded. Length 1-250th to 1-110th.

311. PODOSPHENIA *abbreviata* (*Licmophora,* Agardh). *The rhomboidal Podosphenia* is smooth, broader and shorter than the preceding. Found upon Ceramium diaphonum. Length 1-240th.

312. PODOSPHENIA *cuneata* (*Frustulia,* Agardh). *The broad Podosphenia* is striated, laterally; it is rhomboidal, club-shaped, and slightly pointed. Found in salt water. Length 1-140th.

313. PODOSPHENIA ? *nana. The dwarf Podosphenia* is

smooth. Found, fossil, in the Schistus of Bilen. Length 1-2300th to 1-1720th.

Genus LXVIII GOMPHONEMA. *The wedge little tree Animalcules.*—These Infusoria have a simple siliceous lorica, are fixed upon a distinct filiform pedicle, and develope themselves, by spontaneous self-division, in the form of a dichotomous little tree. The lorica is wedge-shaped, composed of from two to four pieces. At the broad anterior end are two openings, and one in the centre of the dorsal and ventral surfaces. The stalk is an excreted, immovable, horny substance; at its attachment to the lorica there is no opening in the latter; the animalcule can detach itself, creep about independently, and probably form another stalk. In some instances the lorica appears to be transversely striated internally.

314. GOMPHONEMA *truncatum* (*Vorticella pyraria*, M.) *The truncated Gomphonema* is striated. In the *engraving, group* 187, and *figs.* 188 to 190, represent various views of this creature, both separate and attached; these will convey a far better idea of their form, and the mode of attachment of the genus, than any verbal description. Separated animalcules move distinctly. Found free in water and upon lemna, &c. Fossil in Franzenbad and Santi Fiora. Length 1-1720th to 1-280th.

315. GOMPHONEMA *capitatum. The round-headed Gomphonema* is striated, has an elongated cuneiform-shaped lorica, laterally constricted near the rounded end. Length 1-1720th to 1-280th.

316. GOMPHONEMA *gracile. The slender Gomphonema* is smooth? the lorica elongated and wedge-shaped. This species, and the preceding, form a brownish-yellow slime

upon live water plants, especially in spring. Length of wand 1-1150th to 1-860th.

317. Gomphonema *acuminatum. The pointed Gomphonema* is striated, and has elongated wedge-shaped corpuscles. The head-like anterior portion of the lorica terminates in a sharp crest or point; within the body, numerous digestive cells are visible. Found living and fossil. Length 1-860th; sometimes from 1-1720th to 1-430th.

318. Gomphonema *minutissimum* (Greville). *The curved Gomphonema* is smooth (?) wedge-shaped, and curved; club-shaped laterally. Length, without stalk, 1-860th; seldom 1-430th: cluster 1-72nd.

319. Gomphonema *clavatum. The club-shaped Gomphonema* is smooth, short, and cuneiform. Found living and fossil. Length 1-720th: cluster 1-120th

320. Gomphonema *rotundatum. The rounded Gomphonema* is smooth (?) short and obovate laterally. Found upon the roots of lemna. Length of body 1-240th.

321. Gomphonema *discolor. The colourless Gomphonema* is smooth (?) slightly excised at the truncated end. Length 1-600th.

322. Gomphonema (?) *olivaceum. The olive-brown Gomphonema* is smooth (?) oval on the lateral surface, and having dense crystalline short pedicles, and forming a gelatinous-like mass. Found upon Potamogeton. Length 1-2300th.

Genus LXIX. Echinella. *The palm Animalcules* are Bacillaria with simple siliceous lorica, attached to a pedicle. The body is longer than it is broad, wedge-shaped, and developed, by longitudinal self-division, in

the form of a fan, or cluster-like. The chief character of the genus, however, consists in the fact of the self-division not influencing the division of the stalk, for the body often divides again without the stalk taking part in the division. During the division of the body, that of the stalk often rests quiet, either periodically, or for ever. Young forms of Echinella are with difficulty distinguished from species of Gomphonema, and stalkless ones from those of Synedra, to which latter their organization closely approaches.

323. Echinella *flabellata* (*Exilaria,* Greville). *The fan-shaped Echinella* is smooth and shrub-like; the lorica is in the form of a truncated wedge, obtusely tridentated, and longitudinally striated. They are attached by the smaller ends to a stalk, and disposed in a fan-like group. This pretty animalcule covers various marine plants or Algae, as shewn (of the real size) in *fig.* 191; they appear of a golden colour. The thick tender gelatinous branched stalks resemble those of the Vorticella. (See the tree-like *group* 192.) The stem is an excretion produced by the animalcule, probably like the shells of the Molusca, and, like them, is devoid of organic or vital power, and if the fan-shaped bodies separate from it, does not evolve new bodies in the form of gemmae, but disappears. *Group* 193 shews a dorsal and lateral view of a single animalcule. Length, without stalk, 1-120th; height of tree, 1-12th to 1-6th.

324. Echinella *splendida. The beautiful Echinella* is smooth, and branched; the lorica is rather straight or club-shaped, with rounded ends; they are dispersed or arranged in fan-like clusters, at the swollen extre-

mities of branches. Length 1-570th; height of tree, 1-140th.

325. ECHINELLA (?) *paradoxa* (*Styllaria*, Bory). *The heart-shaped Echinella* is smooth and branched; the lorica is wedge-shaped, or heart-shaped, and is tridentated and truncated. They are solitary, or in fan-like clusters; stalks slender. Found in salt-water. Length 1-570th.

326. ECHINELLA *capitata* is smooth, the pedicle branchless; lorica linear, never wedge-shaped, developed in fan-like clusters, attached to Hottonia palustris. Length 1-1150th to 1-570th; height of cluster 1-280th.

327. ECHINELLA (?) *abbreviata*. *The short-footed Echinella* is smooth, the pedicle short and branchless; lorica wedge-shaped, obtusely tridentated, developed in fan-like clusters. Found in spring-water. Length 1-1150th to 1-860th.

328. ECHINELLA *fulgens*. *The glittering Echinella* is striated, and has a short branchless pedicle; lorica linear, truncated at both ends, not cuneiform. Found in salt-water. Length 1-70th.

Genus LXX. COCCONEMA. *The stilt-grain Animalcules* are Bacillaria which have a simple siliceous lorica, composed of two or more pieces, longer than it is broad, and attached by one of its extremities to a pedicle, in the direction of its axis; the lorica is smooth externally, and transversely furrowed internally; it has two central and four terminal openings; hence it is closely allied to Navicula, and might be named *pedicled Navicula*, but the two sides are not symmetrical, as in the latter, though they approach by N. inequalis. The ova cluster is a brownish or greenish mass, divided into four parts; in some one or two bright

spots, the seminal glands of Ehrenberg, are seen. The self-division is longitudinal and ventral, the parts dividing themselves before the restoration of the original form, which, in some specimens, is never restored, the portions remaining like bows, or semi-lunar-shaped pieces. After division both the halves gape, and take an apparently oblique position in regard to the stalk; those bodies which are separated from their stalks have a free movement.

329. Cocconema *Boeckii. Boeck's Cocconema* has a large lanceolate lorica, acute at the extremities, striated, and attached to a branched pedicle. Ehrenberg states he has not seen a central opening, but that there is a ventral one near each end. Found in sea-water. Striae twenty-six to 1-100th of a line. Length 1-430th to 1-210th.

330. Cocconema *lanceolatum.*—Lorica semi-lanceolate, striated; ends obtuse, attached to a branched pedicle, in which they differ from Eunotia turgida (260), and also in the presence of a central opening in the lorica, as shewn in *group* 195. The first figure is a dorsal, the other a lateral view; 194 is a remorse group, moderately magnified. Found in fresh water. Length 1-210th to 1-120th.

331. Cocconema *cistula. The casket Cocconema.*—Lorica small, semi-ovate, striated; pedicle branched, central openings distinct, terminal ones obscure. Free specimens resemble Eunotia faba (264); the young are semi-luniform. *Figures* 196, 197, and 198, represent three specimens of this species. Found, living, on aquatic plants, and fossil at Cassel, Santi Fiora, and Jastraba, in Hungary. Length 1-430th to 1-1150th.

332. Cocconema *cymbiforme* (*Frustulia,* Kützing). *The*

boat-shaped Cocconema.—Lorica lanceolate, extremities acute. Found with the preceding. Length 1-500th to 1-150th.

333. Cocconema (?) *gibbum* (*Cymbella*, Agardh). *The gibbous Cocconema.*—Lorica semi-oval, striated, and slightly constricted at the ends; branches spreading. Found with the preceding. Length 1-2300th to 1-480th.

334. Cocconema (?) *fusidium. The spindle-shaped Cocconema.*—Lorica lanceolate, attenuated, nearly acute at the ends, and smooth. Found, only fossil, with the preceding. Length 1-1150th to 1-620th.

Genus LXXI. Achnanthes. *The standard Animalcules.*—Lorica siliceous, simple, composed of two or more pieces, form prismatic, longer than broad, and having a central opening. In A. brevipes colourless stomach-cells are visible; the pedicle is simple, and its attachment oblique and ventral. They are developed in the form of simple pedicled chains (tablets or bands), which look like little standards, longitudinal self-division commencing beneath the glassy lorica. The members of this genus, whether considered as animals or plants, present us with the simplest examples of organic matter. They are parasitical on Algae, &c.

335. Achnanthes *longipes. The long-stalked Achnanthes.*—Lorica striated, bent in the middle, dorsal and ventral surfaces rounded, pedicle thick, and from two to five times the length of the lorica. Found in sea-water. Length (that is, breadth of band) 1-570th to 1-120th.

336. Achnanthes *brevipes. The short Achnanthes* resembles the preceding species, but the pedicle is much shorter than the body, as shewn in *fig.* 199, 200, and 201,

which represent three groups, or banners, attached to old Vaucheria. The clusters are sometimes many inches in length. *Fig.* 202 is more magnified. Single specimens, when laying on the ventral side, appear spindle-shaped, and shew the oral opening in the middle. Found in salt-water. Length 1-860th to 1-180th.

337. ACHNANTHES *subsessilis. The narrow Achnanthes.* —Lorica small, slender, slightly bent, and striated; pedicle short and thick. Found in fresh and sea-water. Length 1-1150th to 1-430th.

338. ACHNANTHES *exilis. The delicate Achnanthes.*— Lorica smooth (?) slender, and of a pale colour; pedicle slender, often longer than body. Found on Conferva rivularis. Length 1-1150th to 1-570th

339. ACHNANTHES *minutissima. The dwarf Achnanthes.*—Lorica small, slender, and smooth; pedicle length of body. Found upon zygmena. Length 1-1200th to 1-800th.

340. ACHNANTHES *inequalis. The unequal Achnanthes.* —Lorica unequally bent, and smooth. Found, fossil, in Sweden.

Genus LXXII. STRIATELLA. *The zig-zag little standard Animalcules* have a simple siliceous lorica, square, or mostly longer than it is broad, and without a central opening. They are attached obliquely, by one extremity, to a short pedicle, or foot-stalk, and are developed in the form of little banners, one end of which often separates (gaping). (See *fig.* 203.) The ova is at first dispersed in small masses, which afterwards unite.

341. STRIATELLA *arcuata* (*Diatoma rigidum*, D.C.) *The curved Striatella.*—Lorica tabular, nearly square, having

from three to seven internal longitudinal lines, transversely striated. The clusters of banners form curved ribbons; ova greenish-yellow, at first, but becomes reddish or violet. *Fig.* 203 represents two-and-a-half tablets, with dispersed ova, and *fig.* 204 an old one, with them united; they are both attached to sea-weed (Callithamnium). Length of single lorica 1-570th to 1-200th.

Section IV.—*Lorica Invested or Double.*— Lacernata.

Genus LXXIII. Frustulia. *The gelatinous little ship Animalcules* are characterized by a double envelope, the siliceous lorica being enveloped in, and scattered or grouped together among, an indefinitely-formed gelatinous mantle, or lacerna. The true lorica has six openings, two at each end, and two in the middle. The ova cluster is divided into from two to four leaf-like portions; digestive cells and bright glandular organs are often visible. They are closely allied to Navicula. No figure of this genus is given in *Die Infusionsthierchen.*

342. Frustulia *appendiculata* (*Cymbella,* Ag.) *The brownish Frustulia.*—Lorica straight, lanceolate, and smooth (?) ends obtuse; they are scattered through an amorphous gelatine. This species is like Navicula gracilis, but rounded upon the dorsal and ventral surfaces, and more parallel on the lateral ones. The central opening is broad transversely; the end ones are round. Ehrenberg has often observed self-division. Found upon the damp walls of the mineral springs of Carlsbad. Length 1-8000th to 1-1150th.

343. FRUSTULIA *maritima*. *The sea Frustulia.*—Lorica smooth (?) ends rounded, multiplying in groups, in separate, though contiguous, gelatinous cellules. Found, in salt-water, at Swansea. Length 1-1200th to 1-1150.

344. FRUSTULIA *salina*. *The salt Frustulia.*—Lorica striated, very straight and acute, developed in a contiguous gelatinous mass. Found in saline solutions. Length of wands 1-2300th to 1-860th.

Genus LXXIV. SYNCYCLIA. *The ring little ship Animalcules.*—Characters: a double envelope; inner one, or lorica, siliceous, Navicula-shaped; external one indefinitely formed, and gelatinous. The lorica is developed, by decussating self-division, in clusters, within the gelatinous mass. Ehrenberg states there are two openings near the middle, on one side, but they are indistinct.

345. SYNCYCLIA *salpa*. *The tube little ship Animalcules.*—Lorica semi-ovate, and smooth; they are often jointed together, so as to form six ring-like tubes; the ova are bright green. In the engraving, *fig.* 206 represents five groups, imbedded in their gelatinous envelope, which resembles slime upon sea-weed. The upper figure to the right is a single creature; the lower figure is an end view of a cluster of six; the other figures are side views. Length 1-2300th to 1-570th.

Genus LXXV. NAUNEMA.—Characters: a double envelope; inner one, or lorica, siliceous, and Navicula-shaped; external one, or mantle, gelatinous, and tubular. From the self-division of the lorica and body being perfect, and that of the mantle imperfect, they are developed in separated filiform tubes, often branched, presenting a conferva-like appearance. The lorica is incombustible, but the mantle

is not. Two openings only are seen: these are central. In some a canal seems to run from one end to the other. Ova cluster yellow-green.

346. Naunema *simplex* (*Shizomema*, Ag.) *The simple Naunema.*—Lorica oblong, rounded at the ends, and smooth, resembling N. arbuscula. They are disposed in a simple series within flexible filiform tubes. Found upon Ceramium hyalinum, and other sea-weed. Length 1-1150th to 1-570th.

347. Naunema *Dillwynii* (*Monema*, Grev.)—Lorica oblong, Navicula-shaped, small, rounded upon the dorsal and ventral surfaces, and densely arranged in many series, within simple branched tubes. This species is always firmly attached. Found in salt-water. Length 1-2300th to 1-1150th.

348. Naunema *Hoffmanni.*—Lorica small, Navicula-shaped, and smooth; numerous and dense within branched tubes. Found in brackish water. Length 1-1150th.

349. Naunema *arbuscula. The tree-like Naunema.*—Lorica robust, striated, and Navicula-shaped; numerous and dense within erect fruticose tubes. Length 1-860th.

350. Naunema *Balticum.*—Lorica long, narrow, striated, Navicula-shaped. *Fig.* 207 represents a portion of a gelatinous tube surrounding several. They are numerous and dense within flexible branched tubes, which are tufted. Found in salt-water. Length 1-860th.

Genus LXXVI. Gloconema. *The tube grain Animalcules* contain only one species, which is not figured by Ehrenberg. It has a double envelope, the inner one, or true lorica, curved and siliceous; outer one combustible, tubular, often branched, and containing many individuals;

two ova plates, two globular glands, and self-division, are observed. In organization it approaches Cocconema.

351. Gloconema *paradoxum* (*Glojonema*, Ag.) *The wonderful Gloconema* has a semi-ovate, curved, striated lorica, inclosed in hyaline tubes, which are simple, or rarely branched. Ehrenberg remarks, "I found this species very abundantly amongst Mytilus polymorphus, upon Conferva rivularis, and saw both simple and branched threads; the little bodies, or corpuscles, being seldom arranged in two rows, but mostly in one. It is a very remarkable circumstance that I very often found two different sorts of these Navicula-like bodies in the same tube; one was a very delicate and straight kind, evidently a Naunema; the other was the large curved kind. Even to the present moment, I cannot explain this phenomenon, for both sorts were in considerable quantities, and quite free, and therefore it is difficult to suppose one a parasite." Size 1-2300th to 1-860th.

Genus LXXVII. Schizonema. *The rayed little ship Animalcules* have a double envelope; inner one siliceous, Navicula-shaped; the external gelatinous, resembling Naunema, but the tubes are connected together in a bundle-like manner, not branched, though they appear so when spread out.

352. Schizonema (?) *Agardhi. Agardh's Schizonema.*—Lorica very narrow, acute at both ends, placed in a single series; the enveloping tubes are filiform, and enlarged in those places where the siliceous lorica are lodged, as seen in *fig.* 208, which represents a bundle of these tubes magnified 300 diameters. Found on Acus, in the North Sea. Length of lorica 1-720th.

Genus LXXVIII. Micromega. *The tube little tree Animalcules.*—Envelope double or triple, lorica siliceous, mantle gelatinous and tubular, the siliceous one prismatic, similar in appearance to Navicula gracilis; no openings or transverse striae are seen, but two plates of yellowish ova, and longitudinal self-division, have been observed. The Navicula-shaped bodies are connected together by gelatine in bundles, developed in the form of stiff little tree-like clusters.

353. Micromega *corniculatum. The pronged Micromega* has a common cartilaginous trunk, very much branched, cylindrical, and more than the twelfth of an inch thick; the branches are divaricated and short, and the Navicula narrow and lanceolate. Found in the Adriatic. Size of Navicula, 1-1150th.

Appended Tribe of Bacillaria.

Genus LXXIX. Acineta. *The rayed little tree Animalcules.*—The genus Acineta is a neighbouring tribe of the family Bacillaria, the members of which are distinguished by being pedicled, having a simple membranous lorica, and numerous radiating, retractile, but not vibrating tentaculae. In A. Lyngbyi and mystacina stomach-cells have been observed, and in A. tuberosa and mystacina a seminal gland. Self-division not observed.

354. Acineta *Lyngbyi. Lyngby's Acineta.*—Lorica spherical, tentacules in front, the pedicle thick; it resembles a stalked Actinophrys, while the round, radiating, pale yellow-coloured head, with its thick crystal-like stalk, is similar to a retracted Vorticella. Found upon Sertularia

geniculata. Length, including stalk, 1-100th to 170th. Size of ova, below 1-240th.

355. Acineta *tuberosa* (*Vorticella tuberosa*, M.) *The horned Acineta* has a triangular compressed lorica, dilated and truncated anteriorly, and having from two to three obtuse knobs or horns, the lateral ones tentaculated, the pedicle simple and slender. Size 1-210th to 1-100th.

356. Acineta *mystacina* (*Vorticella*, Shrank). *The long-bearded Acineta* is subglobose, obtusely horned, with two elongated fasciculi of tentacules, and a slender pedicle, as seen in *fig.* 205. Found upon Oedogonium. Length of whole body 1-860th to 1-120th.

Family XI.—CYCLIDINA.

The Infusoria of this small family are polygastric, devoid of true alimentary canal, and have but one opening to the body. They have no lorica, their bodies are furnished with cilia or bristles, which perform the function of locomotion, and the various groupings and relations of these afford characters for the discrimination of the genera; a distinct proboscis has been seen. The system of nutrition has been distinctly observed in two species of the Cyclidium; ova has only been seen in Pantotrichum enchelys. No visual organs have been observed.

The genera are distributed as follows:—

Body furnished with cilii	Body compresed—cilii arranged in a single circle	Cyclidium.
	Body round—cilii scattered all over	Pantotrichum.
Body furnished with bristles		Chaetomonas.

Genus LXXX. Cyclidium. *The disc Animalcules* have a compressed body, provided with cilia, placed in a simple circular row. In C. glaucoma, the polygastric apparatus (stomach-cells) is distinct. The mouth is a roundish opening, situated upon the under surface of the body, either close at the anterior extremity, or towards the centre. The organs of locomotion are neither proboscides nor mouth cilii, but are, as in Kerona and Stylonychia, a number of cilii-like feet, situated on the margin of the abdomen. Lately it has been thought that longitudinal lines, produced by rows of very delicate cilii, were present; if so, and an anal opening be discovered,

C. glaucoma would rank under Oxytrichina. Transverse self-division is very common, but longitudinal has not yet been observed. The female sexual apparatus is unknown, but a large round gland is seen in C. glaucoma and C. lentiforme.

357. CYCLIDIUM *glaucoma* (M.) *The blueish Cyclidii* have an oblongo-elliptical body; the abdomen is marginated with cilia, and delicate longitudinal striae are observed upon the back. In swimming, they resemble Gyrinus, or Notonecta, a well-known little black water-beetle (see *Microscopic Cabinet, plate* iv.), which swims in flocks, glancing like silver upon the surface of the water of shady ditches. Sometimes the movement is very quick; at other times the animalcules remain stationary, and then spring with a curvetting motion to another spot. Formerly this species was confounded with G. scintillans; but the latter is much larger. *Fig.* 209 (*plate* iv.) is a side-view, shewing the cilii; *fig.* 211 a dorsal view; and *fig.* 210 a specimen undergoing transverse self-division. They are represented as fed with indigo. Abundant in vegetable infusions in the spring. Length 1-2880th to 1-1150th.

358. CYCLIDIUM *margaritaceum. The pearl Cyclidium.*—Body orbicular, elliptical, the posterior end slightly excised; the dorsal surface has distinct longitudinal lines, the cilii are not distinct. Length 1-1500th to 1-1000th.

359. CYCLIDIUM (?) *planum. The flat Cyclidium.*—Body oblongo-elliptical, smooth; cilii but little marked. Size 1-2640th.

360. CYCLIDIUM (?) *lentiforme. The lenticular Cyclidium* is smaller than the preceding, and has no distinct striae or cilii. Size 1-3180th.

Genus LXXXI. Pantotrichum. *The muff Animalcules.*—Body turgid, covered with moveable cilii. In P. enchelys stomach-cells are distinctly visible. Ova are not satisfactorily seen, though the green colour of P. volvox, and the yellow-coloured matter of the other species, probably indicate its presence. Ehrenberg says, "the absence of a double opening is not yet proved, nor, on the other hand, is its existence."

361. Pantotrichum *enchelys. The elongated Pantotrichum* has a cylindrical oblong body, rounded at both ends. It is of a pale yellow colour, but hyaline at the two extremities, and turbid at the centre. *Fig.* 212 is a cluster of animalcules; those to the left, are more highly magnified than the others. In swimming they revolve and glide along in the direction of the longer axis of the body. Found in infusions of raw flesh. Length 1-1150th.

362. Pantotrichum *volvox* (*Leucophra viridis*, M.) *The rolling Pantotrichum* has an ovate spherical body, of a green colour. Found in brackish water. Size 1-860th.

363. Pantotrichum *lagenula. The flask Pantotrichum* has an ovate body, equally rounded at the ends, and having the anterior ciliated portion produced in the form of a neck or beak. Found amongst conferva. Size 1-1080th to 1-570th.

Genus LXXXII. Chaetomonas. *The bristle Monad Animalcules.*—Characters: oral cilii vibratory; motion slow, and leaping by means of the bristles on the body; these are not vibratile. Very little is known of their organization. They are parasites, living on the dead bodies of other Infusoria, and in infusions of flesh or

animal matter. Whether the delicate vibration seen at the mouth is produced by a proboscis or by cilii is uncertain. In Ch. constricta, transverse self-division is thought to have been seen.

364. CHAETOMONAS *globulus*. *The globular Chaetomonas* is almost spherical, of an ash colour, and possessing setae, or bristles. This animalcule has often the figure of Monas guttula, though the latter is smaller; sometimes two cluster together. Found in bad smelling infusions of animal matter along with Pantotrichum enchelys, Monas termo, &c.; also in the dead bodies of Closterium acerosum, as shewn at *figure* 113, which represents part of the latter, with several animalcules around it. Size 1-2880th.

365. CHAETOMONAS *constricta*. *The constricted Chaetomonas* is transparent, oblong, slightly constricted at the middle, and having two setae, or bristles. Found in dead Hydatina senta. Size 1-5760th.

Family XII.—PERIDINAEA

Comprehends vibrating animalcules, distinctly or apparently polygastric, devoid of an alimentary canal, covered with a shell, or lorica, upon which, or upon the body, are cilia or setae: these are often arranged in the form of a girdle or crown—hence the name is derived. The lorica has only one opening. In three out of the four genera an organ of locomotion is present, in the form of a delicate proboscis, independent of the wreath of cilii around the middle of the body, or scattered cilii, or bristles. In Peridinium pulvisculus and cinctum only has artificial means succeeded in demonstrating the nutritive apparatus; for it is mostly covered by clusters of ova. In Peridinium tripos the seminal glands are evident. In four species, a system of sensation is indicated by the presence of a red-coloured visual point.

The genera are disposed as follows:—

Lorica having stiff bristles or short spines—no transverse furrowed zone	no eye........	Chaetotyphla.
	eye present ..	Chaetoglena.
Lorica smooth or rough—a ciliated transverse zone present	no eye........	Peridinium.
	eye present....	Glenodinium.

Some of the species have been found only in a fossil state; these are obtained from the chalk formations in flint, but are not figured in *Die Infusionsthierchen.*

Genus LXXXIII. Chaetotyphla. *The bur Animalcules* have a siliceous lorica, hispid or spinous, destitute of a transverse furrow or zone, and visual organ. The

surface is covered with little spines and bristles, which appear stronger at the posterior portion of the body. By pressing the animalcule between the plates of an aquatic live-box, the lorica bursts, and sets the little creature in the interior of it at liberty. In swimming it revolves upon the longitudinal axis; this is probably produced by a delicate filiform proboscis or cilii, at its mouth; but though this motion is evident, the organs producing it have not been discovered. Of the nutritive, sensitive systems, &c., nothing positive is known. One species has been discovered in flint, which so closely resembles Zanthidium, that it is often mistaken for it.

366. Chaetotyphla *armata.* *The spinous Chaetotyphla* is of a brown colour, ellipsoidal form, with rounded ends; the posterior is covered with short spines, and has a circlet of black spots, as shewn in the end view, *fig.* 215. The anterior cilii, or fine bristles, are sometimes very indistinct. *Figure* 214 is a variety in which they are strongly marked. Found in clear water, amongst conferva. Length 1-620th.

367. Chaetotyphla *aspera.* *The rough Chaetotyphla* is brown, has an oblong body, rounded at both ends, and rough, with short bristles; the little spines are scattered without order at the posterior end. Found with the preceding. Length 1-570th.

368. Chaetotyphla (?) *pyritae.* *The flint Chaetotyphla* has an oblong cylindrical body, rounded at both ends, and provided with delicate elongated bristles, but destitute of spines. Found, fossil, in flint, near Delitzsch. Size 1-1150th.

Genus LXXXIV. Chaetoglena. *The bristled and*

eyed Animalcules have a siliceous lorica, striped or covered with spines or stiff hairs, and an eye; they are destitute of a transverse zone or furrow. The organ of locomotion is a simple flabilliform proboscis. The interior has scattered transparent vesicles, probably stomach-cells. The ova cluster is a brownish green granular mass; a large bright spot or spermatic gland is also visible. Self-division has not been observed.

369. CHAETOGLENA *volvocina. The rolling Chaetoglena* has an ovate body, with brownish-green ova, and a red eye; between the lorica and the soft body a beautiful red ring is visible in the live specimens. (See *fig.* 216, 217, and 218.) Found, amongst conferva, at Hampstead and Hackney. Length 1-1150th.

Genus LXXXV. PERIDINIUM. *The wreath Animalcules.*—Characters: membranous lorica, with a transverse cilated zone; no eye. The locomotive organs are a filiform proboscis, and the zone or wreath of cilii. In P. pulvisculus and cinctum the digestive apparatus can be demonstrated, by employing indigo and carmine as food; but in P. acuminatum, fulvum, and cornutum, it is visible, without having recourse to artificial means. The oral aperture is found in a hollow near the centre, as in Bursaria. The ova cluster is generally of a brown or yellowish-brown colour, though sometimes it is green, or even almost colourless. In P. tripos and fusus an oval seminal gland is visible. The self-division is longitudinal in P. pulvisculus and fuscum; and, according to some observers, transverse in P. fusus and tripos.

(*a*). *Wreath Animalcules, without horns.*—PERIDINIUM.

370. PERIDINIUM *cinctum* (*Vorticella cincta*, M.) *The green Peridinium* is nearly globular, or slightly three-lobed and smooth, with a zone of cilii; it is not luminous at night. It swims slowly, with a vacillating and rolling motion. Found amongst conferva. Size 1-570th.

371. PERIDINIUM *pulvisculus. The dust-like Peridinium* is small, of a brown colour, and not luminous at night; the lorica is almost spherical, or slightly three-lobed, and a delicate proboscis may be observed, as well as numerous stomach-cells, by feeding it on indigo. Found with Chlamidomonas pulvisculus. Length 1-2300th to 1-1150th.

372. PERIDINIUM *fuscum. The yellowish-brown Peridinium* is not luminous at night; the lorica is oval, slightly compressed, and pointed anteriorly. Length 1-430th to 1-280th.

(*b*). *Wreath Animalcules, with horns.*—CERATIUM.

373. PERIDINIUM (?) *pyrophorum. The flint Peridinium* has an ovate spherical lorica, having two little points at its anterior extremity. It is very delicately urceolated and granulated. Found fossil in the flints of the chalk formation at Berlin. Size 1-570th to 1-480th.

374. PERIDINIUM (?) *Delitiense. The Delitzsch Peridinium* has an ovate spherical lorica, and laterally a little stiff point near the middle. Found fossil in the flints of Delitzsch. Size 1-430th to 1-280th.

375. PERIDINIUM *acuminatum. The pointed Peridinium* is of a brownish-yellow colour, has an ovate spherical

lorica, slightly three-lobed, and having a little process at the posterior end. "I observed this species," says Ehrenberg, "in phosphorescent sea-water from Kiel, and it is very probable that the light proceeded from this animalcule. It is the smallest phosphorescent sea animalcule that is known. Length 1-600th to 1-570th.

376. Peridinium *cornutum* (*Bursaria hirudinella*, M.) *The horned Peridinium* is of a greenish colour, not luminous; its rhomboidal rough lorica has one, two, or three straight horn-like processes in front, and a single one (often curved) posteriorly. Length 1-280th to 1-140th.

377. Peridinium *tripos* (*Cercaria tripos*, M.) *The three-horned Peridinium* is of a yellow colour, and very brilliant in the night (phosphorescent). The lorica is urceolate, broadly concave, smooth, and three-horned; the two frontal horns being very long and recurved, the third, or posterior one, straight. Ehrenberg says, "The power of this creature to evolve light is placed beyond all doubt, as I took up a phosphorescent point nine times, one after the other, from the water, and I saw nothing else in each drop than a single animalcule of this species." It is rigid, and swims with a vacillating rolling motion upon the longitudinal axis. The length of the horns is not constant, sometimes being scarcely as long as the body; at other times much longer. *Figures* 219 and 220 represent an under and side view. Found in the sea, near Copenhagen and Kiel. Length 1-140th; without the horns, 1-430th.

378. Peridinium *Michaelis* was discovered by Dr. Michaelis; it is of a yellow colour, and intensely phosphorescent. The lorica is ovate, spherical, and smooth, with

three short, straight, horn-like processes, as shewn in *fig.* 221. A proboscis is not visible. Found in phosphorescent sea-water. Length 1-570th.

379. PERIDINIUM *fusus. The spindle-shaped Peridinium* is of a yellow colour, intensely phosphorescent, and brilliant at night. The lorica is ovate, oblong, and smooth. The two horns are straight and opposed, giving the creature the form of a spindle, as shewn at *figures* 222 and 223; in the latter the proboscis is in the usual vibrating state. Ehrenberg states that he has seen the cilii of the furrowed zone, and the proboscis single and at rest; also an opening or mouth in the lorica, near the insertion of the proboscis. Length, with horns, 1-120th to 1-90th.

380. PERIDINIUM *furca. The forked Peridinium* is of a yellow colour, and very phosphorescent; the lorica is urceolate, with three horns; two in front short, and in the form of a fork; the posterior is longer. Found in phosphorescent water, at Kiel. Length 1-120th.

Genus LXXXVI. GLENODINIUM. *The wreath Animalcules, with eyes.*—Peridinea with mobile cilii, placed in a transverse furrow, or zone, and provided with an eye. The organization is much the same, in other respects, as those of the preceding genus. In G. cinctum only is a filiform proboscis seen; this emanates from the middle, and, like the wreath of cilii, vibrates. This organ, though hitherto unobserved, is probably present in the other species. The lorica is combustible. The stomach-cells and minutely-granulated ova are visible in all the species, but the former are very distinct in G. apiculatum. The red eye is in the form of an elongated or

horse-shoe shaped spot, and forms an essential character of the genus. Longitudinal self-division has been observed only in G. cinctum.

381. Glenodinium *cinctum. The yellow Glenodinium.*—Lorica oval, or nearly spherical, and smooth ; eye large, semi-lunar, and transverse. Found in fresh water, amongst oscillatoria. Size 1-570th.

382. Glenodinium *tabulatum. The tabulated Glenodinium* is oval, of a yellowish green colour; the lorica is granulated and reticulated with elevated lines, but not spinous; truncated and denticulated posteriorly, and bidentate anteriorly ; eye oblong. Size 1-570th to 1-430th.

383. Glenodinium *apiculatum. The spinous Glenodinium* is oval, of a yellowish green colour; the lorica is smooth, but tabulated at the margin with hispid furrows, as shewn in *figures* 224, 225, and 226. The eye is oblong, and extremities obtuse. Found amongst conferva, where chara grows. Size 1-570th to 1-430th.

FAMILY XIII.—VORTICELLINA.

These polygastric animalcules are provided with an alimentary canal, the extremities of which are distinct, though they approximate, in consequence of its curvature (anopisthia). They have no lorica; when free, they are solitary, but when attached to a pedicle they are social, often assuming elegant remorse forms, like little trees, an animalcule surmounting and terminating each branch or pedicle. These clusters are produced by their imperfect mode of self-division.

The animal organization of this family is very distinct, with the exception of vessels and nerves. All the species possess numerous cilii; those of Stentor are covered with them; others have them at the mouth; they are mostly disposed in the form of a wreath. By the vibratile action of these, locomotion is effected. In some genera, as in Vorticella, Carchesium, and Opercularia, longitudinal and transverse muscles are seen. The polygastric nutritive apparatus may be observed in all the genera, by feeding them upon artificial colouring food. The course of the alimentary canal has been observed in all the genera except Trichodina and Urocentrum; the mouth and discharging opening, both lying in the same lateral cavity, have also been demonstrated in all. The sexual system is hermaphrodite, and self-division is known in all except Zoothamnium, which is rare. In four genera the latter mode of propagation is imperfect; hence they form beautiful little tree-like clusters. Another mode of propagation is observable,

namely, the growth of gemmae on the side of the animalcules, or their pedicles. Although a system of sensation is not indicated by the presence of eyes, we may presume the existence of them, by their great irritability when approached.

The genera are distributed as follows:—

Body without stalk	Tail absent......	Body covered with cilii............		Stentor.
		Body smooth, cilii anterior.......		Trichodina.
	Tail present			Urocentrum.
Body periodically stalked—often branched like a tree	form of stalked bodies similar	Stalk flexible, deflection spiral	Simple	Vorticella.
			Branched	Carchesium.
		Stalk inflexible		Epistylis.
	Bodies with different forms	Stalk inflexible.......................		Opercularia.
		Stalk flexible, deflection spiral....		Zoothamnium.

The following curious particulars relating to metamorphosis are appended to this family by Ehrenberg:—

"The Vorticella developes, a pedicle divides (casts its exuvia), developes posterior cilii, loosens itself from the pedicle, rambles about, draws in (after shedding a second exuvia) the posterior cilii, sheds them, and firmly attaches itself, in order to put forth another stalk and build a trunk. This cycle of phenomena is repeated again and again, and possesses high physiological interest; it is a returning circle of transformations, a return to an early condition, similar to that of a butterfly, if it suddenly lost its wings and antennae, and again became a caterpillar, in order once more to return to the state of pupa and butterfly, or as an old man becoming a child, in order to run again his course of life anew."

Genus LXXXVII. Stentor. *The trumpet Animalcules* comprehend ciliated tail-less Vorticellina, who have

no pedicle or stalk, are free, but can attach themselves by the posterior extremity of their bodies, which, assuming at pleasure, the form of a cone, enables them to adhere to various substances, like leeches. The body is entirely covered with cilii, and a wreath of larger ones surmount the fore part. The function of locomotion is performed by their cilii, while their anterior wreath are likewise special organs for purveyance. Ehrenberg considers the longitudinal striae along the body, and the circular ones at the anterior part, muscular fibres. The anterior wreath of cilii are coiled up in a spiral form, near the mouth, and in some species a row of long ones proceed from the mouth, in a fringe-like manner, to the middle of the body. The nutritive apparatus consists of numerous berry-like stomach-cells, connected together, and presenting a moniliform or necklace-like alimentary canal, which proceeds from the mouth along the body, and returns, uniting with it in a spiral-shaped cavity. Oscillatoria, Rotatoria, and Monads, are often found abundantly in the stomach-cells. They increase by self-division, either longitudinal or oblique; also from ova; these form a net-like granular mass, cover the stomach-cells, and vary in colour in different species; they have also a gland-like sexual body, resembling the soft roe of fish, whose shape is band-like, moniliform, or round, and a contractile bladder.

All the species are visible to unassisted vision, and are best examined between the plates of a large live-box, a portion of the decayed stem or leaf on which they are found being put in with them.

384. STENTOR *Mülleri.* *Müller's Stentor.*—This is the

white funnel-like polypi discovered by Trembly; it is large, the crown or wreath of cilii is interrupted, and the lateral crest of fringe is indistinct. When swimming, the animalcule is usually contracted in the form of an egg, but when attached, it stretches itself out, like a trumpet. When several are swimming in a glass vessel, they will gradually congregate, and select some particular spot, and then attach themselves, evincing, as it were, not only a degree of sociality, but, says Ehrenberg, a mental activity. These animalcules feed upon coloured food very readily; the ova are white, the spermatic gland moniliform. When kept a long time in cylindrical glass vessels they fasten themselves to the sides, form a slimy covering around them, and die. Found upon lemna and other water-plants, even under ice. Size, stretched out, 1-20th; contracted, 1-120th.

385. STENTOR *Röeselii.* *Röesel's Stentor.*—In form, size, and crest, this resembles the preceding species, as shewn, elongated, at *fig.* 233; and contracted, as it swims, at *fig.* 234; the latter representation is rather more magnified. The seminal gland is long, non-articulated, ribbon-shaped, as seen in the engraving. Above the gland are seen two of the stomach-cells, and the crest or fringe; at (*) is the contractile vesicle. In colour this species is more of a yellowish-white than the preceding. Found upon flocky decaying reeds, leaves &c. Common, in summer, in standing water on stones. Length 1-140th; extended, 1-24th.

386. STENTOR *caeruleus.* *The blue Stentor*, or *funnel-shaped Polypi*, resembles, exteriorly, the two preceding species, but the ova are blue; the gland is articulated and chain-

like, as seen in the engraving, *fig.* 235 and 236 (*plate* v.); the lateral crest and frontal wreath, or crown of cilii, are continuous. When kept in glass vessels they often fix themselves to the sides in clusters. Self-division has not yet been observed. They are best examined under a microscope, when placed in a large live-box. A magnifying power of 100 diameters is sufficient. Found amongst vaucheria. Length 1-480th.

387. STENTOR *polymorphus. The green Stentor* resembles the preceding in form. The ova are of a beautiful green-colour, the gland articulated and chain-like, the lateral crest indistinct, and the frontal wreath of cilii interrupted. This species will not receive indigo readily. Transverse self-divison has been observed. Found upon stones, decayed sticks, and leaves, in standing water. Length 1-120th to 1-24th.

388. STENTOR *igneus. The fire-coloured Stentor* is less than the preceding, the ova is of a yellowish-green colour, the skin bright yellow or vermillion, the gland is spherical, lateral plume or crest absent, and the frontal wreath of cilii interrupted. Found by Ehrenberg upon the water violet (Hottonia palustris). Length 1-72nd.

389. STENTOR *niger* (*Vorticella nigra,* M.) *The brownish-black Stentor* is small, of a dark brownish-yellow or blackish colour, the ova olive coloured, the gland is spherical, the lateral crest absent, and the frontal wreath of cilii continuous. This species is often so abundant that it colours large pools, in turfy hollows, of a dark black, resembling an infusion of coffee. The swimming movement of this species is readily seen (as in the others) with the naked eye. Size 1-96th.

Genus LXXXVIII. Trichodina. *The urn Animalcules.*—Vorticellina destitute both of tail and pedicle. They are distinguished from the preceding genus by the surface of the body being destitute of cilii; they possess a vibrating fasciculus or wreath of cilii, situated anteriorly; the oral opening is simple, and not spiral. They are mostly disc-shaped, or conical. Three species have a wreath of cilii around the anterior part, and on one side of the margin is a simple oral opening. T. pediculus has the posterior end abruptly truncated, like the front, and is surrounded with a wreath of curved setae, which it employs as feet. In T. tentaculata there is a kind of proboscis. The polygastric structure can be demonstrated in T. pediculus and grandinella by coloured food; in the other species it may be observed without artificial aid. In all, the ova are clear and limpid as water. A kidney-shaped gland is seen in T. pediculus.

390. Trichodina *tentaculata. The tentaculated Trichodina* has a discoid-shaped body, as shewn at *fig.* 227 (*plate* iv.); it is destitute of the wreath of cilii, but it has a fasciculus of vibratile cilii, and a styliform proboscis, as seen in the engraving. Size 1-280th.

391. Trichodina *pediculus* (*Cyclidium pediculus,* (M.) *The parasitical Trichodina* has a depressed body, of an urceolate and discoid shape, as shewn at *fig.* 228, 229, and 230; a wreath of vibratile cilii anteriorly, and another of short moveable uncinated cilii, or hooked setae, upon the back. Ehrenberg remarks, "I have fed this species many times with indigo, and have seen numerous stomachs filled with the blue matter; it always runs upon the back, where there is a wreath of twenty-four to twenty-eight mobile

hooks (or uncinate cilii), having the mouth and vibrating wreath of cilii (of forty-eight to sixty-four) directed upwards." It appears to feed upon the little granules of the body of the fresh water polypi, drawn in *plate* vii. of the *Microscopic Cabinet*. *Fig.* 228 and 229 are side views, attached to a portion of a polypi; *fig.* 230 is a top view. Size 1-570th to 1-280th.

392. TRICHODINA *vorax*. *The voracious Trichodina* has an oblong, cylindrical, slightly conical body; anterior part convex, and crowned with cilii, the back rather attenuated and smooth. Size 1-570th.

393. TRICHODINA *grandinella* (M.) *The hail Trichodina* is nearly spherical, the back sharply attenuated; a wreath of cilii surrounds the truncated fore part. This species is liable to be mistaken, by an inexperienced observer, for a free Vorticella; its true character appears to be in its open wreath of cilii. Size 1-1500th to 1-860th.

Genus LXXXIX. UROCENTRUM. *The top Animalcules* are free, have a tail-like style, but destitute of pedicle and cilii, except a wreath anteriorly; mouth aperture simple. The internal organization, as far as it is known, is similar to the preceding genera. Perfect transverse self-division has been observed. Ehrenberg thinks the eyes, supposed to have been seen by Müller, were most probably the vestigia of some of the cilii, none of which he appears to have seen.

394. UROCENTRUM *turbo* (*Cercaria turbo*, M.) *Müller's Urocentrum* is hyaline, and has an ovate, trilateral body, with a style, or setaceous tail, one third of its length. Ehrenberg says, "The little tail is not a separable Vorticella-stalk, but an articulated style on the back—perhaps a

foot. Found amongst lemna and conferva. *Figure* 232 is a dorsal view, and 231 a side view. Size 1-430th to 1-280th.

Genus XC. Vorticella. *The bell-shaped Animalcules* are crowned with cilii anteriorly, and have a pedicle or stalk, when young, but which, at a later period, and also after the first self-division, is wanting. Their shape, when pediculated, is similar; the pedicle can be suddenly deflected spirally by means of the long muscle within it, but it is never branched. The wreath of cilii, and the long muscle, with the hollow pedicle, are organs of locomotion. At certain periods a second wreath of cilii is said to be produced at the posterior part of the body. Not only can numerous stomach-cells be seen, but likewise, according to Ehrenberg, the gradual passage of the food onwards, in a twining sort of intestinal canal, though he says the latter is not easily observed, on account of the periodical deflection of the pedicle. On this account it is more satisfactorily seen in the genera Epistylis and Opercularia. The mouth and discharging orifice are separate, but lie in the same hollow, at the anterior margin. The propagative structures are variously coloured; clusters of ova, an elongated gland, and a round contractile bladder, exist; in fine, the animalcules are androgynous. The supposed increase by the growth of young animalcules out of the pedicle, like flowers on the stem of a plant, has arisen from erroneous observation. When the animalcule loosens itself from its pedicle or stalk, a circumstance which, says Ehrenberg, "takes place at certain periods, the stalks die, or disappear; just like the shells of crabs, or as nail and hair." The muscular fibre within the stem requires stops,

or an achromatic condenser, under the stage, to render it distinct.

395. Vorticella *nebulifera* (*V. nebulifera et convallaria*, M.) *The nebulous Vorticella.*—The body of this creature is in the form of a bell, that part answering to the mouth of the bell being expanded, and the margin fringed with cilii; the pedicle or stalk, which is about five times the length of the body, is attached to the convex apex, which is rather conical, when the creature is in health, but hemispherical when otherwise. The mouth is situated near the margin, in which place the wreath of cilii is interrupted. These creatures usually congregate together, though each is independent of its neighbour; for on the approach of any foreign body to one, it withdraws, by coiling up its pedicle, while the others remain stretched out in search of food. By this action the pedicle is not contracted, but merely deflected, by means of the long muscle within it, so that it can form as many as ten coils, like the spring of a bell. The body of the animalcule does not contract or become wrinkled, but the margin of cilii appears sometimes bent inwards. In colour, when seen in masses about the roots of lemna, they appear white. An amplification of 300 diameters is necessary to exhibit the cilii. Longitudinal self-division may often be observed, during which the body becomes broader. Gemmae, or buds, shoot out from the sides of the other species, but have not been noticed in this. Found abundantly on the stalks of lemma and water-plants, even in winter under ice. Length of body 1-570th to 1-280th.

396. Vorticella *citrina* (M.) *The yellow Vorticella.*—The body is more hemispherical than the preceding, and

the frontal margin more expanded. Found upon lemna, rarely, with the former species. Length of body 1-430th to 1-210th; stalk three to four times that length.

397. Vorticella *microstoma. The small-mouthed Vorticella* has an ovate body, attenuated at both ends, and having the frontal margin narrow, not expanded. The body, during contraction, is annulated; its colour whitish-grey. The mouth, stomach, reception of coloured food, male glands, ova, and long muscle of the stalk, have all been observed in this species, as also spontaneous longitudinal and transverse self-division, and the growth of gemmae. Ehrenberg counted from twenty to twenty-four cilii in the frontal wreath. Found in stagnant water. Length of body 1-2300th to 1-240th; length of stalk six times that of the body.

398. Vorticella *campanula* (*Vorticella lunaris*, M.) *The great Vorticella* has an hemispherical bell-shaped body, with the frontal margin broad and truncated; not expanded. Colour whitish-brown; (ring, none). This species forms a thick blueish matter upon water-plants, and the single animalcules are discoverable with the naked eye. Size 1-120th; stalk seven times longer than the body.

399. Vorticella *hamata. The fish-hook Vorticella* has a small ovate hyaline body, attenuated at both ends; the pedicle is obliquely attached to the body, so as to form something of a fish-hook appearance. Length of body 1-570th.

400. Vorticella *chlorostigma* (*Vorticella fisciculata*, M.) *The green Vorticella* has a green, ovate, conical and campanulate body, which is annulated (wrinkled). The frontal margin is expanded; the cilii, contractile bladder, and green

ova, are to be seen, but the seminal gland, self-division, and growth of gemmae, have not been observed. In water this creature often covers grasses and rushes with a beautiful green layer. Length 1-240th; stalk five times the length of the body.

401. Vorticella *patellina* (M.) *The dish-shaped Vorticella* has an hemispherical body, campanulate, the frontal portion very much dilated, and the margin of it expanding greatly, and often reflexed. Length 1-480th; stalk about seven times the length of the body.

402. Vorticella *convalaria* (*V. craterformis, citrina, gemella, globularia, hiaris, nasuta et truncatella: Enchelys fritillus, Trichoda gyrinus,* M.) has an ovate, conical, campanulate body, the frontal portion dilated, and its margin slightly expanded. It is annulated, and of a hyaline or whitish hue. This appears to have been the first infusorial animalcule discovered. Leeuwenhoek, the discoverer, found it in stagnant rain-water, at Delft, in April, 1675. It is found in considerable abundance, upon the surface of vegetable infusions, with V. microstoma, from which it is distinguished by its broad front, which gives to it a bell-shaped or campanulate appearance. Carus, in 1823, represented it as arising from spontaneous generation (generatio spontanea) in oil. The medium was an accidental mixture of oil colour and spring water. Ehrenberg remarks, the appearance arose in a very natural way. It has been described under various names by different naturalists. Ehrenberg gives 38 references to different works treating on it. *Figure* 237 (*plate* v.) is a group of three, with the pedicle of another, to shew the manner in which it deflects it spirally.

Figures 238 and 239 are two stalkless creatures; from their different appearances in the latter state, Müller has described them not only as different species, but under different genera. In *Die Infusionsthierchen*, there are eighteen names under which that author has described them. Length 1-430th to 1-24th; stalk six times its length.

" This entertaining and well-known animalcule is usually found attached to any extraneous body, as the leaves of duck-weed, small aquatic shells, clusters of ova, and the larvae of insects; an example of the latter is shewn in the *Microscopic Illustrations, fig.* 30, where it may be considered as a *parasite*, or rather an *epiphytes*. As they are, when fully developed, attached mostly to some stationary object, they afford many facilities to the microscopist for his observation; they form a good object also for ascertaining the defining power of his instrument, and his expertness in its management, as much of the effect will depend on the manner in which he directs the illumination. If this be not attended to, and the instrument has not sufficient power and penetration, it will only exhibit two cilii instead of a circular row; indeed, this animalcule is described and drawn in this manner, in the old authors, an error which recent improvements in the microscope have demonstrated.

" When in search of prey they stretch out the stem, and by means of a vibratory motion communicated to the cilii they agitate the water, and occasion a current towards them; this brings along with it the small particles of matter on which they feed. Should any circumstance disturb the water, or a large animal approach them, they

instantly retract, bending the stem into a number of coils; this operation is performed so quickly, that the eye cannot detect it; in a few seconds, the creature may be observed slowly uncoiling the stem. These curious animalcules are endowed with several methods of propagation, the observation of which has thrown much light upon this interesting subject, and enlarged our views of the operations of Nature in her minute productions: many creatures which we formerly considered as belonging to distinct genera are now ascertained to be the same in different conditions. One method of increase is probably from ova; but of this we have no direct evidence. Dr. E. considers that the spawn is ejected, as with the Kolpoda, and that it does not proceed from buds, or germs from the roots; their first appearance is like several little specks, rather darker than the surrounding mass, and possessing a tremulous motion; they are then not more than the 1-12000th of an inch in diameter, and are clustered about the roots or stems of the old ones; they do not change their situation, and are probably connected to the parent group by invisible filaments; they soon increase in size, when delicate stems may be perceived, as may also a current in the water towards the bell, indicating the presence of cilii. At this stage of their growth, they have been considered as a distinct species by Schrank, under the title of V. monadica, because at this period the stems do not contract spirally, as in the old ones. From some of the specimens observed by Müller, it is evident that they are also produced by buds.

"The next method of propagation is by a division of the parent. When this is to be effected longitudinally, the

bell increases in breadth; a separation then commences, and double circles of cilii are formed; the body of the animal then divides, and other cilii grow around the dome of the bell; by constantly whirling, one or both of the bells separate from the stem, and swim about, in which condition they have been classed as a distinct genus, under the name Urceolaria. Should it happen that both the bells are twisted off, the stem remains stationary, and does not contract afterwards, or produce a new bell. The most striking peculiarity which presents itself next is, that the end formerly attached to the stem swims foremost, and from the other extremity proceeds the new stem; before, however, this is effected, it changes its form, and sometimes buds out, or separates; the latter is the genus Eclissa of Schrank, and the former, with the small protuberance, Rinella of Bory St. Vincent. If the creature retain its bell shape, be not inverted, and exhibits the lower cilii, it forms the genus Kerobalina of the latter naturalist, and when all the cilii are invisible, then he calls it the genus Craterina. Again, it constitutes the genus Urceolaria when the anterior cilii are alone observed. Besides those already mentioned, there are many other changes in its form; sometimes it stretches itself out in length, and becomes cylindrical, so that it is readily mistaken for a species of the genus Enchelys; in this condition, one or both ends bend themselves, while it is swimming past a hard body; finally it separates transversely in twain.

"The next method of propagation is by the bud formation, which is not confined either to the animalcules with or without a stem. During this process, it passes through

a variety of shapes, moves briskly in the water, and forms the genus Ophrydia of Bory St. Vincent. Ehrenberg has divided this species into two varieties, founded on the shape of the bell; when they are nearly globular, he calls them *campanulata;* when pointed, *pyriformis.*"

403. VORTICELLA *picta. The dotted Vorticella* has an ovate, conical, campanulate body, the frontal portion dilated, and its margin slightly expanded. The pedicle is very slender, and curiously marked throughout its length with red dots. Length 1-1150th to 1-570th; stalk four to five times as long.

Genus XCI. CARCHESIUM. *The tree and trumpet Animalcules* are closely allied to the preceding genus, from which they are distinguished by having their spirally flexible pedicle branched, in consequence of imperfect self-division. The bodies upon the pedicle are all of the same form. The organization of this genus is not so well known as Vorticella and Epistylis. A simple wreath of cilii, which during quick vibration appears double, is observable; and another, at certain periods, at the posterior part of the body: within the pedicle, a transversely-folded thread-like muscle is observed during contraction; the mouth (which is lateral) and polygastric alimentary canal are distinct. Of the propagative system, whitish ova, granules, and a contractile bladder, are seen; but a spermatic gland is not very distinct. Imperfect longitudinal self-division is a very marked character; the growth of gemmae has been observed, and the periodical separation of the body from the stalk gives rise to free animalcules, as in Vorticella.

404. CARCHESIUM *polypinum* (*V. polypina*, M.) *The bell-like Animalcule* of Leeuwenhoek has a conical, cam-

panulate body, the frontal portion broad, truncated, and the margin expanded. The colour is white, the pedicle is branched, the division being subumbellate. The stomach-cells are easily discerned, when indigo is mixed with the water, and the mouth is thus indicated by the particles becoming approximate near it. The reception of coloured food into the œsophagus is observable; but its passage from one digestive sac to the other is so quick, that the alimentary canal has not been seen and traced as a continuous tube; it is similar to the act of swallowing in large animals, the food not remaining for any length of time in the œsophagus before it passes into the stomach. *Figures* 240 to 245 represent tree-like clusters, except *fig.* 244, which is a single free animalcule. *Figures* 240 and 241 are only slightly magnified, the latter is contracted. In *figures* 242 and 245, as also the free pedicle, *fig.* 243, the muscle is very distinct. This muscle was first observed by Mr. Varley. Size 1-570th to 1-430th; ova granules 1-24000th.

Genus XCII. Epistylis. *The pillar Animalcules.*—Vorticellina with a rigid pedicle, either simple or branched, and having all the corpuscles of the same figure; or, in other words, they are Vorticella or Carchesei with a rigid pedicle, without its internal muscle. The pedicle, or stalk, appears to be a hollow tube. Their polygastric structure, and the situation of the united mouth and anal opening, are easily demonstrated by the employment of coloured food. In E. plicatilis, the whole course of the alimentary canal can be seen. The granular ova, says Ehrenberg, have been measured in several species; a contractile bladder, and a short band-like male gland, are observable in many; the

latter, however, is spherical in E. nutans. Self-division has been seen in E. anastatica, galea, plicatilis, flavicans, leucoa, digitalis, and nutans; and it is probable that the free forms possess transverse division. In E. nutans and plicatilis, gemmae have been seen; but these are never produced by the stalk.

405. Epistylis *galea. The helmet Epistylis* is large, has a conical body, contractile by transverse folds; mouth lateral and projecting, pedicle thick, branched, and articulated. Found upon Ceratophyllum. Size of body 1-120th.

406. Epistylis *anastatica* (*V. anastatica, crataegaria et ringens,* M.) *The rose of Jericho Epistylis* has an oval body, without folds, the frontal margin dilated and projecting, and the pedicle dichotomous, smooth, or squamulous, with foreign particles. Stomach-cells and a united mouth are to be observed, but the alimentary canal has not yet been seen. The granules of ova are white by reflected light, and yellowish by transmitted. The clear bladder-like gland is often to be seen, but not its contraction. Growth of gemmae unknown; self-division longitudinal. Found upon Ceratophyllum, and also upon small-shelled water Molusca. Size 1-280th; height of little tree 1-140th; ova 1-12000th; cyclus of development 1-12000th to 1-280th.

407. Epistylis *plicatilis* (*V. anularis et pyraria,* M.) *The folded Epistylis.*—Body conical and elongated, contractile in folds, frontal margin dilated, truncated, and slightly projecting. Pedicle dichotomous; smooth, or, when foreign bodies adhere, having a scaly appearance. They are often corymbose. This species is white to the naked eye, but some-

what yellow beneath the microscope; it is very much like the preceding, is often found with it, but is distinguished by being larger, by its ring-like folds when contracted, and by the tasselled or tufted appearance of the cluster. Size 1-280th to 1-210th.

408. Epistylis *grandis. The great Epistylis.*—Body broadly campanulate, stalk decumbent, slender, smooth, the branches flexible and without articulations, but much tufted. This is not only the largest fresh water species of Epistylis, but it also forms the greatest masses. Its proper colour is a blueish-white, but it often appears of a yellow or greenish hue, from the colour of its food. Found upon Ceratophylla and Nymphaea, often in masses several feet long, and two to three inches thick; it appears like a blueish-white slime, which is easily broken up. Size 1-140th to 1-120th.

409. Epistylis *flavicans* (*V. acinosa et belis,* M.) *The yellowish Epistylis.*—Body large, broadly campanulate, pedicle smooth, and the branches coarctate. The branches are dilated at the axillae, and the ova are of a yellow colour. In this species, the alimentary canal is very evident. Size (stretched out) 1-190th; tree 1-9th high.

410. Epistylis *leucoa* (*Volvox sphaerula,* M.)—*The white granulated Epistylis* has the body large, broadly campanulate, pedicle erect, smooth, and articulated; the branches are capitate, or collected in a head; the ova white. These animalcules are convex anteriorly, have distinct ova granules, a simple wreath of cilii, and a round mouth at the margin. The seminal gland is bent in the form of the letter S. Size 1-120th; tree 1-24th; ova

1-5760th to 1-6000th; cyclus of development, consequently, 1-6000th to 1-120th.

411. EPISTYLIS *digitalis* (*V. digitalis, ringens et inclinans,* M.) *The thimble Epistylis.*—Body small, cylindrical, campanulate, dichotomous, and finely annulated. This well-marked form infests the Cyclops quadricornis, drawn and described in the *Microscopic Cabinet.* It sometimes completely envelopes it. Ehrenberg says it does not appear to be deadly to it; but I consider it a disease. In its beautiful little tree, the Notommata petromyzon nestles just like a bird in a bush, and fastens its eggs to its branches; coloured food is readily taken in by this animalcule, and fifteen large stomach-cells have been counted. Size 1-430th; tree 1-20th.

412. EPISTYLIS (?) *nutans. The nodding Epistylis.*—Body ovate, attenuated at both ends; mouth distinctly two-lipped and prominent. The pedicle is branched and annulated. (See *fig.* 245 and 246.) This animalcule, says Ehrenberg, "can push forth a bladder between its lips, like (si parva licet componere magnis) a camel can its palate veil (gaumen segel)?" Size 1-430th; tree 1-24th.

413. EPISTYLIS *botritis. The botritis Epistylis* has a very small ovate body, crowned with cilii. They resemble grapes upon a simple hyaline pedicle. Size 1-2400th; tree 1-240th.

414. EPISTYLIS *vegetans* (*Volvox vegetans,* M.) *The plant-like Epistylis* has a very small ovate body, crowned with cilii (?) they are disposed in clusters, like the preceding, upon a branched pedicle, of a yellow colour. When the water containing this species is coloured with indigo, strong currents are seen at the front or head of each

animalcule, and a vibratile organ is observable at each little head; but whether it is a wreath of cilii, or a simple proboscis, is undetermined; if the latter, this creature would belong to the Monads, where it would form the type of a new genus. Found in river water. Size 1-3450th; tree 1-140th. .

415. Epistylis *parasitica. The parasitical Epistylis* has a small body, conical, campanulate, and solitary; pedicle simple and smooth. Found upon Zoobotryon pellucidus. Length 1-570th; with pedicle, 1-120th to 1-24th.

416. Epistylis *Arabica. The Arabian Epistylis* has a small oval campanulate body; pedicle but little branched, smooth, and hyaline. Found in the Red Sea. Size of tree, 1-140th.

Genus XCIII. Opercularia. *The parasol little bell Animalcules* have a stiff rigid pedicle, branched, from imperfect spontaneous division. The pediculated corpuscles are of different forms; they have two lips—the supeperior one, supported by a muscle, is somewhat like a parasol. They may be called Epistylis with dissimilar corpuscles. The organs of locomotion consist of a wreath of cilii, and a long muscle within the body; this rises or depresses the frontal surface, in the form of an upper lip. At the large, lateral, somewhat anterior mouth, to and from which the alimentary canal is seen running, the discharge of matter also takes place. They are hermaphroditic; self-division, and free separation of the body from the stalk, have been observed. It is very remarkable that below its proper bodies, more especially in the axillae of the branches, there are seen large single bodies, and even

larger egg-shaped ones, having hairs at their point, and only a little round, but not vibratile, opening. The latter ones are most probably parasitical bodies, the others are not. This genus is not figured by Ehrenberg.

417. Opercularia *articulata* (*V. Opercularia*, M.) *The articulated Opercularia* is in the form of a little shrub, 1-6th to 1-4th high, white and dichotomous. This animalcule readily takes in carmine and indigo; and Ehrenberg states, he saw as many as forty-four stomach-cells filled, resembling a girdle in the middle of the body. The stalk is very delicately striated in a longitudinal direction, and shews, at its divarications, a transverse line, or joint. Found upon Dyticus marginatus. Size 1-430th.

Genus XCIV. Zoothamnium. *The double-shaped little bell Animalcules* comprehend Vorticellina with a flexible spiral pedicle, having an internal muscle, and becoming branched, from imperfect spontaneous division. The stalked corpuscles are of different shapes, and have a simple lateral mouth opening. In one species, a wreath of cilii, placed around the frontal region, constitutes the locomotive apparatus; and a special muscle or fibre runs along the branches and stem. Artificial means are able to demonstrate numerous round stomach-cells. No reproductive organs have been detected; but simple and compound self-division has been observed.

418. Zoothamnium *arbuscula* (*Vorticella racemosa*, M.) *The tree-like Zoothamnium* has the branches of the little tree in racemes or umbels; the corpuscles being white, and the pedicle very thick. (See *fig.* 247, which is more highly magnified than 248). These beautiful little trees resemble plumes of feathers, at once distinguishing them-

selves by their strong branches, but having the characters of Carchesium and Opercularia, as respects the presence of globular bodies in the axillae of the branches. When full grown, all the animalcules free themselves from the pedicle, which afterwards withers and disappears. Found upon Ceratophyllum. Size 1-430th; tree 1-4th; stalk 1-4th the thickness of the body.

419. Zoothamnium *niveum.* *The Abyssinian Zoothamnium.*—Branches short, alternate, and almost verticillate; bodies oblong, white, clustered at the ends of the branches; some are round and attached to the trunk; the branches are filiform, the lower ones often deserted, while the upper bear clusters of club-shaped little bodies, rounded anteriorly. Size 1-210th.

Family XIV.—OPHRYDINA

Comprehends loricated polygastric animalcules, solitary or aggregate, possessing a distinct alimentary canal, a separate mouth and discharging orifice, which approximate and terminate in the same cavity. In organization it resembles the family Vorticella; in fact, says Ehrenberg, they are true Vorticella or Stentores inclosed in a gelatinous or membranous combustible little box (shell). The locomotive apparatus consists of a frontal wreath of cilii; the genus Ophrydium has a second wreath placed posteriorly, and Tintinnus an elastic muscular stalk or tail. Although the polygastric organs of nutrition can be demonstrated in all the tribe by using coloured food, only in Ophrydium has an alimentary canal been distinctly seen by Ehrenberg. In Vaginicola and Cothurnia longitudinal division of the body without the lorica has been observed. In Ophrydium transverse division without the lorica is known.

The genera are disposed as follows :—

Forming Monad clusters, though incomplete self-division of the lorica			Ophrydium.
Single anamalcules, no self-division of the lorica	body furnished with an elastic pedicle attached to lorica		Tintinnus.
	body stalkless	lorica stalkless	Vaginicola.
		lorica stalked	Cothurnia.

Genus XCV. Ophrydium. *The gelatinous little bell Animalcules* are characterized by their possessing a gelatinous lorica, and are clustered (resembling gelatinous balls), in consequence of perfect self-division of the body, but imperfect of the lorica. This division gives rise to very peculiar external appearances, for each body very frequently

divides itself, the two portions separating entirely; the gelatinous lorica forms only a separating wall. In this manner thousands and millions of connected animal cells are quickly formed, appearing as gelatinous masses. They resemble minute Algæ of the genus Nostoc, and have been placed with ulva, fucus, conferva, &c., by different botanists.

420. Ophrydium *versatile* (*Trichoda inguillanus et Vorticella versatilis*, M.) *The green Ophrydium* has elongated corpuscles, attenuated at both ends, vividly green, and associated in smooth and globular polypi clusters or masses, which vary in size from that of a pea to that of a ball five inches in diameter; they are either free or attached. Ehrenberg states that in May, 1837, he saw hundreds of clusters as large as the fist, which, by the evolution of gas, were at intervals elevated to the surface and driven by the wind to the edge of the water. Longitudinal self-division has been seen by the same observer, and he is inclined to believe that Schrank's representation of transverse division is erroneous. In the engraving, *figures* 249, 250, represent quarters of small globular masses of clustered animalcules not magnified. *Figures* 251 and 252 represent parts of such a mass magnified. *Figures* 253 and 254 single animalcules, the former stretched out. Found in sea-water. Length of single animalcule, stretched out, 1-120th.

Genus XCVI. Tintinnus. *The clapper little bell Animalcules.*—Ophrydina which possess divisibility of the body, but not of the urceolate lorica; the body is attached to the interior of the lorica by a flexible pedicle (somewhat similar to the clapper of a bell). The organs of locomotion are a wreath of cilii and the elastic pedicle; the mouth

serves both as a receiving and discharging orifice; the stomach-cells, as well as traces of a yellowish ova cluster, are more or less visible; self-division was known to Müller.

421. TINTINNUS *inquilinus. The cylindrical Tintinnus* has an hyaline or yellowish coloured body, with a cylindrical glass-like, bell-shaped lorica. (See *group* 255.) Length of body, without the stalk, 1-570th; with, 1-240th.

422. TINTINNUS *subulatus* (*Vorticella vaginata,* M.) *The pointed Tintinnus* has an hyaline conical lorica, with a posterior subulate elongation. Ehrenberg observes that if this elongation or pointing of the lorica should be called a stalk, we should require a new generic name for the animal. Length of lorica 1-90th.

Genus XCVII. VAGINICOLA. *The Sheathed little bell Animalcules* comprehend Ophrydina distinguished by divisibility of the body, but not the lorica, and neither of them pediculated; a wreath of cilii surrounds the truncated frontal portion, within which, at the margin, is the orifice or mouth. The polygastric apparatus, the passage of the food onwards, its return, and the exit of the refuse near the mouth, have been seen by Ehrenberg. One species (V. crystallina) has coloured ova granules. No other reproductive organs have been observed satisfactorily. Increase by longitudinal self-division has been seen in all the species.

423. VAGINICOLA *crystallina* (*Vorticella stentorea et Trichoda ingenita,* M.) *The crystalline Vaginicola.*— Lorica crystalline, straight, pitcher-shaped, slightly contracted near the open end; ova green. Found upon lemna, &c. Length of lorica 1-210th.

424. VAGINICOLA *tincta. The brown Vaginicola.*—

Lorica brownish-yellow, urceolate, and nearly cylindrical; body hyaline. Found upon Zygnema decimum. Size of lorica 1-280th.

425. Vaginicola *decumbens.* *The decumbent Vaginicola.*—Lorica brownish-yellow, oval and compressed, as shewn in the engraving, *group* 256. The lorica is decumbent, the body hyaline. Lives with the preceding. Length of lorica 1-280th.

Genus XCVIII. Cothurnia. *The stilt little bell Animalcules* possess divisibility of the body, but not of the lorica, which is urceolate in shape, and erected on a rigid buckskin-like pedicle. A wreath of cilii is placed upon the flat frontal region, and the mouth, joined with the anal opening, lies sideway within it. The body is elastic, and can withdraw itself within the stiff lorica: polygastric apparatus and longitudinal self-division have been observed in two species. The sexual structures are not satisfactorily seen.

426. Cothurnia *imberbis (Vorticella folliculata,* M.) *The beardless Cothurnia* has the pedicle much shorter than the lorica, the body of a yellowish colour. Ehrenberg remarks, "This animalcule had often swallowed green Monads, and yet accepted indigo. Trichodina vorax is the enemy of this species." Found upon Cyclops quadricornis. (*Mic. Cab., plate* viii. *group* 257.) Length of lorica 1-280th.

427. Cothurnia *maritima.* *The sea Cothurnia* has a pedicle much shorter than the hyaline lorica; the body is hyaline and whitish. Length of lorica 1-570th.

428. Cothurnia *Havniensis.* *The Copenhagen Cothurnia* has a pedicle much longer than the hyaline lorica; the body is whitish. Size, without the stalk, 1-280th.

Family XV.—ENCHELIA.

We now arrive at Infusoria which possess a much higher organization than those hitherto described, and which have a distinct alimentary canal, with the mouth and discharging opening at opposite extremities of the body. These animalcules are destitute of lorica; organs of locomotion have been observed in all the genera, and in all the species except two, but in no case do they consist of simple vibrating proboscides, but generally of numerous vibratile cilii. In the genera Actinophrys, Trichodiscus, and Podophrya, locomotion is performed by slow-moving feelers. In seven genera the organs of nutrition have been satisfactorily demonstrated, by the employment of coloured food, but only in one has the entire course of an alimentary canal been traced, though in most its course is indicated by the discharge at the end of the body Ehrenberg states the polygastric structure is to be seen in all except the Arabian Disoma. A double condition, as regards the sexual apparatus, is seen in Enchelys, Leucophrys, and Prorodon. Complete self-division, both longitudinal and transverse, has been observed; but neither gemma or polypi clusters. The members of this family appear to me to resemble each other less than any membranous one that has preceded. The most curious animalcules among them are the double-bodied Disoma and the teeth-bearing Prorodon.

The genera are distributed as follows:—

Teeth absent.	surface of body destitute of vibratile cilii	direct truncated mouth (no lip)	vibratile cilii at the mouth	body simple		Enchelys.
				body double?		Disoma.
			ray-like tentaculi not vibratile	stalkless	the body covered with rays	Actinophrys.
					rays at the edge	Trichodiscus.
				stalked		Podophrya.
		oblique truncated mouth (with lip)	no neck			Trichoda.
			with neck			Lacrymaria.
	surface of body with vibratile cilii	oblique truncated mouth, with lip				Leucophrys.
		direct truncated mouth, no lip				Holophrya.
Teeth present						Prorodon.

Genus XCIX. Enchelys. *The cylinder Animalcules.* —Characteristics: Enchelia with body single, no vibratile cilii upon its surface; mouth truncated (direct, not oblique), devoid of teeth. A wreath of cilii is distinctly to be observed around the mouth in three species; in one it is indistinct. In E. pupa the form of the alimentary canal is accurately seen; the polygastric cells, mouth, and discharging orifice, are recognized in all. In E. pupa and nebulosa, very delicate ova granules are observable, and in E. farcimen a contractile bladder. The self-division is transverse and complete.

429. Enchelys *pupa* (M.) *The doll Enchelys* has a turgid club-shaped body, attenuated anteriorly. The granulated ova are of a pale yellowish-green colour, and disposed around the stomach-cells; neither glands nor seminal bladder are visible. *Figures* 258 and 259 represent two specimens: in the first the currents produced by the cilii around the mouth are distinct; they are both represented as fed on coloured substances. It is remarkable that this is the only species of Polygastrica of which

Dr. Ehrenberg has figured, in his large work, the form of the nutritive system separately. Common in stagnant bog water. Length 1-140th.

430. Enchelys *farcimen* (*E. farcimen et Vibrio intestinum*, M.) *The sausage-shaped Enchelys* is smaller, more cylindrical and slender than the preceding species; the ova are whitish. These creatures prey on other animalcules nearly as large as themselves, which they devour entire; this will account for the variety of forms which they assume, and require an observer to be very watchful and cautious before he can pronounce on the identity of a species. Dr. Ehrenberg, by patient observation, saw one individual undergo a great variety of forms when it had swallowed a young Kolpoda cucullus. To explain this effect, *fig.* 260 shews a young specimen with open mouth, about to devour an animalcule; this it accomplishes by the motion of the fringe of cilii producing a current in the water; the prey by this means is brought into contact with the mouth aperture, which gradually dilates till the animalcule is entirely inclosed. During this operation it swims about, and a casual observer would imagine the form shewn at *fig.* 261 as the normal shape of another animalcule, while, in fact, it is occasioned by its food; as the digestion proceeds the lower part dilates, and the anterior contracts into its former shape; the animalcule then assumes an egg shape (*figures*, 262 to 265), and finally returns to its true form. Found in stagnant water. Length 1-430th.

431. Enchelys *infuscata*. *The brown-mouthed Enchelys* has an oval or spherical whitish body; the mouth encircled by a brownish ring, and not prominent. When fed with

indigo numerous digestive cells become filled. Found in bog water. Size 1-280th to 1-240th.

432. Enchelys *nebulosa* (M.) *The nebulous Enchelys* has an ovate hyaline body, with a projecting mouth. This species receives carmine and indigo very readily. Ehrenberg has counted as many as nineteen digestive cells filled with the coloured food. Size 1-230th to 1-570th.

Genus C. Disoma (?) *The double-bodied Animalcules.*—This curious genus is characterized by the presence of a double body, destitute of cilia; that part at which the mouth is situated is truncated (direct). The mouth is ciliated, but devoid of teeth. Within the bodies numerous little vesicular cells (stomachs) are observed, and the discharge of excrement may be seen to take place at the posterior extremity of each body.

433. Disoma *vacillans.* *The vacillating Disoma* has binary corpuscles, filiform and slenderly club-shaped; it is hyaline and attenuated at the anterior extremity. Ehrenberg remarks, "Both bodies frequently swam parallel beside each other, so that they turned on their long axis and moved onwards quickly, though vacillating; sometimes both bodies gaped widely apart from each other, but never so widely as to form a straight line. (See *fig.* 265*.) Found on Mount Sinai. Size 1-380th.

Genus CI. Actinophrys. *The sun Animalcules.*—Enchelian Infusoria, of a globular shape, covered with setaceous tentacula, but without vibratile cilii. The part at which the mouth is situated is truncated (direct). The progress of the discovery of the organization of this genus is as follows:—In 1773 the mouth was indistinctly observed; in 1783 both the mouth and reception of

coloured food were distinctly seen by Eickhorn; in 1777 Eickhorn noticed the erection and depression of the tentacules or rays, and locomotion produced thereby; in 1830 Ehrenberg saw the polygastric structure, and the discharging orifice opposed to the mouth; also a short proboscis in Ac. sol. Granular matter, probably representing ova, is seen in all the species. Müller saw a round gland, and Eickhorn self-division.

434. Actinophrys *sol* (*Trichoda sol*, M.) *The whitish Actinophrys.*—Body spherical, of a whitish colour, rays few, and about the length of the diameter of the body. Ehrenberg says, "The rays or tentacules serve to feel, to move, and to catch." Meyen states he has seen the rays, or tentacules, when cut off, twist themselves, but Dr. Ehrenberg considers that eminent botanist to have mistaken them for Vibrio bacillus, which is mostly present with this species. The mouth is large and round, and has a proboscis; Eickhorn appears to have seen much larger forms, so that they could be seen with the naked eye, and found within them whole (!) forms of small Entomostracis! Found in the dust-like matter upon the surface of infusions. Size 1-1200th to 1-430th.

435. Actinophrys *viridis*. *The green Actinophrys.*—Body spherical, greenish, rays numerous and shorter than the diameter of the body, as shewn in *fig.* 266. Found amongst conferva. Diameter of the body, exclusive of rays, 1-620th to 1-280th.

436. Actinophrys *difformis*. *The gibbous Actinophrys.*—Body irregular, lobed, and hyaline; rays variable in length, some longer than the diameter of the body. Diameter, without the rays, 1-570th to 1-280th.

Genus CII. Trichodiscus. *The rayed-disc Animalcules.*—Body depressed, marginated with a single row of setaceous tentacules; vibratile cilii and teeth absent; no pedicle: the mouth truncated (direct).

The flat disciform shape of these Infusoria resembles those of the genus Arcella, but, unlike the latter, these are soft and shell-less, with the rays stiff, like bristles. A central opening, and probably a large lateral gland, have been recorded by Ehrenberg, who likewise states that he has seen, though indistinctly, numerous digestive cells, but that reception of coloured food was not observed, nor the situation of the anal orifice.

437. Trichodiscus *sol.* *The sun Trichodiscus.*—*Figures* 267 and 268 have a depressed almost flat body, hyaline or yellowish, with variable rays. The motion of this species is very sluggish; it often remains for a long time inert. Found amongst conferva. Diameter, without the rays, 1-430th to 1-210th.

Genus CIII. Podophrya. *The pedicled and rayed Animalcules.*—Enchelia devoid of vibrating cilii and teeth; their bodies are spherical, pedicellated (free), and covered with setaceous tentacules. The mouth truncated (direct). In organization they are similar to Actinophrys, with a stiff stalk.

438. Podophrya *fixa* (*Trichoda fixa*, M.) *The fresh-water Podophrya* has a spherical, turbid, whitish body, with a glass-like pedicle, slightly excised at the extremity. The rays or setæ have their extremities capitate, and equal the diameter of the body in length, as represented at *figures* 269, 270: the latter exhibits it with two animalcules it has seized. Dr. Ehrenberg states the seizing or catching power

of this animalcule is very interesting to observe. As soon as a specimen of the quick vibrating Trichodina grandinella approaches to and comes in contact with its tentacules it is immediately taken prisoner, ceases to vibrate, and stretches out its cilii backwards (Opisthotonus). On the whole, this species resembles the Acineta, from which it is separated by Dr. Ehrenberg, who supposes it to possess a discharging orifice, though its situation is unknown. Found among dust-like matter upon the surface of pond water, and perhaps, says Dr. Ehrenberg, in the sea (Copenhagen). Diameter 1-430th.

Genus CIV. Trichoda. *The hair Animalcules.*—Body devoid of hairs or cilii; mouth truncated (oblique), destitute of teeth, but provided with vibratile cilii, and having a lip, but no neck. The polygastric apparatus is satisfactorily proved by the employment of coloured food, and the posterior anal spot is also known. The oblique surface of the mouth forms a very characteristic upper lip-like projection. In T. pyrum only has self-division been observed. All the species are colourless.

439. Trichoda *pura* (*Kolpoda pyrum*, M.) *The clear Trichoda*, represented at *figures* 271, 2, 3, has an oblong club-shaped body, with small vesicles. The anterior part is attenuated, and the mouth lateral. Common in vegetable infusions, usually with Cyclidium glaucoma. Size 1-720th.

440. Trichoda *Nasamonum*. *The Lybian Trichoda.*—Body cylindrical, extremities equally obtuse, the mouth large and elongated laterally. Size 1-288th.

441. Trichoda *ovata*. *The egg-shaped Trichoda.*—Body ovate, turgid, attenuated anteriorly; mouth small and lateral. Size 1-480th.

442. TRICHODA (?) *Æthiopica. The Æthiopian Trichoda.*—Body oblong, attenuated posteriorly, and the under side flat; mouth large. Size 1-600th.

443. TRICHODA *Asiatica. The Asiatic Trichoda.*—Body oval, oblong, cylindrical, rounded at both ends; mouth small. Size 1-860th.

444. TRICHODA *pyrum* (*Kolpoda pyrum*, M.) *The pear-shaped Trichoda.*—Body ovate, turgid, acute anteriorly. Found amongst conferva and infusion of celery. Size 1-1200th.

Genus CV. LACRYMARIA. *The tear Animalcules.*—Body furnished with a long narrow neck, slightly enlarged near the termination, where the ciliated and lateral (lipped) mouth, destitute of teeth, is situated. The body is not ciliated. Locomotion is performed by means of the neck, the distensible body, and the cilii at the mouth. The proboscis-like lip is very short, sometimes distinctly articulated, and projects but little beyond the oral orifice. Its polygastric structure can be demonstrated by employing coloured food, and its discharge at the end recognized in one species; in another green (ova) granules are present.

445. LACRYMARIA *proteus* (*Trichoda proteus*, M.) *The changeable Lacrymaria.*—This creature has an oblong turgid body, with delicate transverse folds. The neck is capable of considerable extension, as seen in the engraving (*plate* vi.), *figures* 274, 5; in the former it is extended, in the latter contracted. It resembles Trachelocerca olor, but its posterior extremity is rounded, at the centre of which is the discharging orifice. Reproductive organs are unknown. Found amongst lemna. Size, stretched out, 1-140th.

446. LACRYMARIA *gutta. The drop-like Lacrymaria* has a smooth and nearly spherical body, with a very long neck. Found with conferva. Size 1-1150th; including neck, 1-210th.

447. LACRYMARIA *rugosa. The wrinkled Lacrymaria.*—The body of this animalcule is nearly globular, and wrinkled; the neck is of a medium length, and the ova green. In swimming it often revolves on its longitudinal axis; neither cilia nor an enlargement is observable near the mouth. Size 1-570th; including neck, 1-288th.

Genus CVI. LEUCOPHRYS.

This interesting genus is characterized by having vibratile cilii upon the whole surface of their body, and a mouth obliquely terminal, without teeth. From the oblique position of the mouth the upper part appears like a lip. The cilii, which cover the body, are short and disposed in rows; those around the mouth are longer, and produce very powerful currents. In swimming all the species revolve upon the longer axis. A serpentine alimentary canal (with numerous grape-like stomach-cells, more than fifty), terminating at the opposite extremity to the mouth, is present. In three species, numerous ova granules are observed, and in some, one or two globular glands and simple contractile bladders. Transverse and longitudinal self-division has been observed.

448. LEUCOPHRYS *patula* (*Trichoda patula*, M.) *The gaping-mouthed Leucophrys.*—This creature has an oval, campanulate, turgid body, as shewn in *figures* 276, 7. It is sometimes quite pellucid, at others of a whitish colour. The mouth is ample and gaping. The stomach-cells are very large, and fill themselves in an irregular manner; when

the animalcule is quiet, the passage of the food onwards is seen (during eating) in the serpentine canal to which the stomachs are attached, like berries; even, says Dr. Ehrenberg, the stalk or short tube connecting them is visible when they receive or discharge coloured food. The longitudinal rows of cilii are very numerous in full-grown specimens. The ova are white by incident light, brownish by transmitted; in the middle of the body is a small globular male gland. Found both in fresh and sea water. Size 1-280th to 1-96th.

449. LEUCOPHRYS *spathula* (*E. Spathula*, M.)—This creature has a lanceolate, compressed, whitish body, membrane-like at its anterior extremity, where it is obliquely truncated, and a narrow mouth situated. Found amongst lemna. Length 1-140th.

450. LEUCOPHRYS *sanguinea* (*Trichoda striata*, M.) *The red Leucophrys.*—This beautiful-coloured creature, shewn at *fig.* 279, has a cylindrical body, rounded at both extremities, and of the colour of blood. Ehrenberg remarks that within it are two bright contractile round bladders, and when the creature undergoes self-division, as shewn in *fig.* 280, there is always one in each part. Length 1-144th; ova granules 1-12000th.

451. LEUCOPHRYS *pyriformis* (*Kolpoda pyrum*, M.) *The pear-shaped Leucophrys* has an ovate whitish body, rather more acute anteriorly, ventricles large. Size 1-570th to 1-280th.

452. LEUCOPHRYS *carnium* (*Kolpoda pyrum*, M.)—Has an oval oblong body, acute anteriorly, and of a whitish colour, ventricles narrow. Found in putrescent animal water, and draining of manure. Size 1-1440th to 1-430th.

453. LEUCOPHRYS (?) *anodontae* (*Leucophra flinda*, M.) *The muscle Leucophrys* has an oval, turgid, and transparent body, rounded at both extremities. Found in Siberia and Copenhagen. Size 1-430th.

Genus CVII. HOLOPHRYA. *The wool Animalcules* comprehend Enchelia covered with vibratile cilii; the mouth anterior, directly truncated, and without lip or teeth. They might be termed ciliated Enchelyses. The digestive cells have been seen in all the species, and in two the mouth and discharging orifice. The cilii are disposed in longitudinal rows. In H. ovum, organs of propagation (green granules and a posterior contractile bladder) are observable; self-division appears to be transverse in H. discolor.

454. HOLOPHRYA *ovum* (*Leucophra bursata*, M.) *The egg-shaped Holophrya.*—Body ovate, somewhat cylindrical, extremities sub-truncated. (See *fig.* 281.) The ova are green. Found amongst lemna and conferva. Size 1-570th to 1-210th.

455. HOLOPHRYA *discolor* (*Trichoda horrida*, M.) *The conical Holophrya.*—Body white, ovate, conical, sub-acute at the posterior extremity; the cilii long and scattered. Found amongst conferva. Size 1-240th.

456. HOLOPHRYA *coleps* (*Leucophra globulifera*, M.) *The cylindrical Holophrya* has an oblong, cylindrical body, rounded at both extremities. It is of a white hue. Size 1-430th to 1-280th.

Genus CVIII. PRORODON. *The toothed-cylinder Animalcules.*—This remarkable genus is distinguished by its directly truncated mouth, furnished with a circlet of internal teeth. The body is covered with vibratile cilii. A

polygastric system of nutrition (with the anterior and posterior orifices of the alimentary canal) has been observed, by feeding on colouring matter. A long band-like gland and contractile bladder, with a granulated mass, are seen in P. niveus.

457. Prorodon *niveus. The white Prorodon.*—Body large, elliptical, and compressed; colour white; circlet of teeth compressed, as shewn separate at *fig.* 283. Found amongst conferv a in turf pools. Length 1-72nd ; ova granules 1-2400th.

458. Prorodon *teres. The cylindrical Prorodon.*—Body ovato-cylindrical, as represented at *fig.* 282; it is of a white colour, circlet of teeth cylindrical. Ehrenberg counted twenty teeth; when broken up, forty-five. In swimming it revolves upon the long axis of the body. Size 1-140th.

Family XVI—COLEPINA.

The animalcules of this small family are loricated, and possess a polygastric alimentary canal, whose orifices are placed at the opposite extremities of the body. The lorica is in the form of a small cask, composed either of minute plates, placed in a row, or of little rings, between which cilii are situated. Anteriorly the lorica is truncated, smooth, or toothed, the mouth ciliated posteriorly, the shell terminates in from three to five little points. The digestive cells in these creatures are readily filled with coloured food, and its remains ejected posteriorly. The ova granules are coloured in C. viridis; in the other species they are colourless; complete transverse self-division has been observed in one species.

Genus CIX. Coleps. *The little box Animalcules.*—This being the only genus, its characteristics are identical with those of its family.

452. Coleps *hirtus* (*Cercaria hirta,* M.) *The hairy Coleps.*—This brisk little creature has an oval white body. Its lorica is composed of small plates, and between them, both transversely and longitudinally, are rows of cilii. The tablets terminate anteriorly in nineteen pointed processes, and posteriorly in three, as shewn in the engraving, *fig.* 284. The mouth is furnished with cilii, as seen in *figure* 285; *figure* 286 is an end view of the lorica.

In my work on Animalcules, I have stated the difficulty there was in examining it, from its restless habits; and Ehrenberg makes a similar statement, and says, in swimming it is difficult to perceive its lorica, but when dried, or

pressed between glasses, the little shields composing it are rendered visible. Found amongst conferva. They are rather scarce. Length 1-570th to 1-430th.

460. Coleps *viridis. The green Coleps.*—Body oval and ciliated, lorica composed of plates terminating in three points. Found amongst conferva. Size 1-960th to 1-570th.

461. Coleps *elongatus. The long Coleps* has a cylindrical elongated body, lorica tabulated, white, and terminating in three points; transverse self-division has been observed. Size 1-570th to 1-430th.

462. Coleps *amphacanthus. The crowned Coleps* has an ovate body; lorica is composed of rings, and the anterior part crowned with unequal teeth, the posterior having three strong spines. Found in the body of Spirostomum vireus. Size 1-280th.

463. Coleps *incurvus. The curved Coleps.*—Body oblong, nearly cylindrical, and slightly curved; lorica tabulated and terminating in five points. Found amongst conferva. Size 1-430th.

Family XVII.—TRACHELINA.

This extensive family includes those polygastric animalcules which have an alimentary canal with two distinct orifices, the receiving one lateral, the discharging one terminal. They have no lorica. The bodies of all the genera, except Phialina, are covered with vibrating cilii; these are generally disposed in longitudinal rows, and those near the mouth are longest. The cilii serve as organs of locomotion. Trachelius has no neck, but the frontal portion of the body is prolonged in the form of a long proboscis-like lip; in Loxodes and Chilodon it is like a hatchet-shaped broad lip. In Glaucoma there is a tremulous flap to the mouth; and in Chilodon and Nassula the teeth sometimes project before the mouth. The genera Bursaria and Nassula have a thick frontal protuberance, caused by the alimentary canal being curved anteriorly; numerous stomach-cells are observable, and their reception and discharge of coloured matter can be seen in all the genera. The teeth in Chilodon and Nassula, and the violet-coloured bile (gall) of the latter genus, are worthy of notice. In Spirostomum the mouth is of a spiral shape; reproductive organs are of a double kind in all the genera. Complete transverse and longitudinal self-division is frequent, but neither the formation of gemmae nor clusters are observed.

The genera are disposed as follows:—

Teeth absent.	no tremulous mouth flap	brow continuous with the body	mouth simple	with a brow-like upper lip	lip long, proboscis-like..	Trachelius.
					lip broad, hatchet-shaped	Loxodes.
				brow-like prominent back		Bursaria.
			Mouth spiral			Spirostomum.
		Brow discontinued in a peg-like manner				Phialina.
	Mouth having a tremulous flap					Glaucoma.
Teeth present.	A brow-like prominent upper lip					Chilodon.
	A brow-like prominent back					Nassula.

Genus CX. Trachelius. *The neck Animalcules* are characterized by having their bodies ciliated, a simple mouth destitute of teeth, and the upper lip very much elongated in the form of a proboscis. This latter organ, along with the cilii, serves for the purpose of locomotion; in three species, however, no cilii are to be seen. The mouth is seated at the base of the proboscis in four species. In four species, also, the polygastric structure of the alimentary canal has been demonstrated by coloured food, and in three the discharging orifice; but, from the rounding off of the extremities of the others, the latter has only been presumed. In T. meleagris the gall is of a pale red colour. The propagating apparatus of two species is hermaphroditic; in the others it is only partially demonstrable. In T. ovum, and T. meleagris the expulsion of ova granules has been seen. Two species increase by transverse self-division.

464. Trachelius *anas* (*Trichoda anas et index,* M.) *The goose-like Trachelius.*—Body white, clavate, and cylindrical; proboscis thick, obtuse, and shorter than half the body; mouth situated close to the base of the proboscis. *Fig.* 287, 287*, exhibit two full-grown Infusoria; the former exhibits the currents it produces to bring the food

within its reach; *fig.* 288 is a specimen undergoing transverse self-division; and *fig.* 289 a young one. Found in exposed infusions, and amongst conferva. Size 1-280th to 1-120th.

465. Trachelius *vorax*. *The voracious Trachelius* has a clavate ovate body, turgid white colour, and thick obtuse proboscis, shorter than half the body; the mouth is situated near the middle of the body, and not at the base of the proboscis. Found amongst conferva. Size 1-120th.

466. Trachelius *meleagris*. *The pearl Trachelius* has a compressed lanceolate body, often curved in the form of the letter S, with a thick obtuse proboscis, shorter than half the body; it has along the back a series of vesicles, like a string of pearls. Size 1-96th to 1-72nd.

467. Trachelius *lamella* (*Kolpoda lamella*, M.) *The flat Trachelius* has a depressed laminated body, of a linear lanceolate shape, often truncated anteriorly, and rounded at the end. Size 1-900th to 1-280th.

468. Trachelius *anaticula*. *The little goose-like Trachelius.*—Body white, small, ovate, pyriform, attenuated and diaphanous anteriorly. Found amongst conferva. Size 1-570th to 1-280th.

469. Trachelius (?) *tricophorus* (*Vibrio strictus*, M.) *The whip-shaped Trachelius* has a cylindrical changeable body, often clavate; the proboscis capitate, and in the form of a very delicate whip. Size 1-1200th to 1-430th.

470. Trachelius (?) *globulifer*. *The spherical Trachelius* has a spherical hyaline body, with a very delicate whip-like acute proboscis. Found amongst conferva. Size 1-200th.

471. Trachelius *ovum*. *The egg-shaped Trachelius.*—

This creature, which is represented in the engraving, *fig.* 290, has an ample ovate body, broadly open, in a campanulate form anteriorly; proboscis short, in the form of a beak. The colour is white. In no infusorial animalcule is the alimentary canal so easily seen as in this, as also the large mouth and contractile vesicle laying over the lower part of the alimentary canal; numerous small digestive cells and ova granules appear in every part. Found in stagnant bog water. Size 1-72nd.

Genus CXI. LOXODES. *The lipped Animalcules* have their bodies covered with cilii, a simple mouth devoid of teeth, upper lip continuous and broad, hatchet-shaped; the organs of locomotion are the rows of cilii and the long ones near the mouth. Coloured food has demonstrated the polygastric structure of three species, and in one its expulsion has been observed. In L. bursaria propagating apparatus of a double kind, viz. ova granules, an oval gland, and two contractile globular vesicles, have been seen, and in two others the granules only; self-division transverse.

472. LOXODES *rostrum* (*Kolpoda rostrum*, M.) *The beaked Loxodes.*—Body white, lanceolate, slightly curved in the form of an S, in consequence of the lip being a little uncinated. Ehrenberg states that he has very often seen large Naviculæ and Synedræ within this creature, but that it would not feed on coloured food. The cilii are very delicate. *Fig.* 291 represents an animalcule which has fed upon Bacillaria; *fig.* 292, another creeping along conferva; and *fig.* 293 a specimen undergoing transverse self-division. Found amongst conferva. Size 1-144th to 1-60th; ova granules less than 1-24000th.

473. LOXODES *cithara* (*Trichoda aurantia*, M.) *The*

harp-shaped Loxodes.—Body triangular and compressed, anteriorly it is dilated and obliquely truncated, but pointed at the posterior extremity. Colour white. Size 1-430th to 1-210th.

474. Loxodes *bursaria.* *The green Loxodes.*—Body oblong, anteriorly it is obliquely truncated and depressed, posteriorly hemispherical. Found in bogs. Size 1-280th.

475. Loxodes *plicatus.* *The wrinkled Loxodes.*—This small creature has an elliptical depressed body, convex on the back, and slightly plicated; the lip is uncinate. Found on conferva. Size 1-430th.

Genus CXII. Bursaria. *The purse Animalcules.*—This interesting genus is composed of creatures covered with cilii, the anterior part convex, their mouth not terminal, though simple, toothless, and devoid of tremulous flap. The cilii serve as organs of locomotion, and are distinctly seen in coloured water; they are generally disposed in rows, those around the mouth are longer than the others. The nutritive system consists of an alimentary canal, curved forwards; it is furnished with digestive cells resembling little purses, which are attached to it by short stalks. The mouth is large, not situated, as in Leucophrys, obliquely at the anterior extremity of the body, but laterally, so that, as it were, a brow either projects over it or else forms the end. The bile is white or reddish, the propagative apparatus hermaphrodite in three species, and in five but partly known. Self-division, longitudinal or transverse, has been observed in five species.

(*a.*) *Sub-genus* Bursaria.—*The inferior* (*not anterior*) *lip reaching to the frontal margin.*

476. Bursaria *truncatella* (M.) *The truncated Bur-*

saria has a large, white, ovate, turgid body, truncated and broadly excavated in the front, which has a simple row of cilii. In some specimens, Ehrenberg saw half-digested Rotiferae, and large quantities of vegetable matter, in the nutritive cells, and was able to see the canal fill itself with carmine, but could not follow the whole course of it. In each cell the food is surrounded by a clear fluid, which Ehrenberg calls bile. A large bright bladder is seen below the mouth, and somewhat to the left of it, on which side is a large curved but not articulated gland, reaching to the brow or front. Found in ditches, in woods, amongst rotten beech leaves. Size 1-48th to 1-36th.

477. Bursaria *vorticella*. *The bell-shaped Bursaria.* —Body white, large, nearly spherical, and turgid; the anterior truncated, and widely excavated, having a double row of cilii. Found with Chlamidomonas pulvisculus and Gonium pectorale, some of which are seen within it in *fig*. 294. Size 1-108th.

478. Bursaria *vorax*. *The voracious Bursaria.*—Body large, oblong, rounded at the ends; mouth ample, being one third the length of the body, and touching the summit of the frontal region. This species has great resemblance to Urostyla grandis and Stylonychia lanceolata, when their claws and styles are withdrawn. Found, in summer, in muddy water. Size 1-140th to 1-108th.

479. Bursaria *entozoon*. *The worm Bursaria* has a large cylindrical, turgid body, nearly equally rounded at the extremities; small mouth, situated undér the frontal apex. Found, with the following, in the rectum of Rana temporaria, in summer and winter.

480. Bursaria *intestinalis* (*Vibrio vermiculus*, M.)

The intestinal Bursaria has a slender cylindrical body, attenuated posteriorly; mouth small, below the frontal apex. In this species, as well as in others, Ehrenberg has seen transverse self-division. Size 1-240th to 1-120th.

481. BURSARIA (?) *cordiformis. The heart-shaped Bursaria.*—Body reniform, front depressed, mouth slightly curved in a spiral manner; colour white. Size 1-210th.

482. BURSARIA *lateritia* (*Trichoda ignita*, M.) *The brick-red coloured Bursaria.*—Body compressed, ovato-triangular, with the front sharply crestated. Found with lemna, conferva, &c. Size 1-430th to 1-144th.

(*b.*) FRONTONIA.—*Anterior part of the body* (*brow*) *projects beyond the mouth, and is convex.*

483. BURSARIA *vernalis* (*Leucophra virescens*, M.) *The spring Bursaria* has an oval turgid body, rounded at the ends, and attenuated posteriorly. The mouth has a wreath of stiff short bristles, resembling teeth; numerous stomach vesicles are often filled with large Oscillatoriae, Naviculae, &c., and contain a reddish bile. The process of digesting the Oscillatoriae is interesting to follow:—they are at first elastic and rigid, and of a beautiful blue green colour, then distinctly lax, flexible, and bright green, becoming afterwards yellowish-green, and falling into separate articulations, which at length turn yellow. Found amongst oscillatoria in spring. Length 1-144th to 1-120th.

484. BURSARIA *leucas. The white Bursaria.*—Body oblong, cylindrical extremities nearly equi-convex, bile colourless (see *fig.* 295). This creature has a contractile bladder, with a curious jagged margin near the long open mouth. Found with oscillatoria, and on the surface of water. Size 1-144th.

485. Bursaria *pupa*. *The doll-like Bursaria.*—Body white, ovato-oblong, rather acute posteriorly, mouth aperture inferior, and near the frontal apex (see *fig.* 296). Found in chalybeate water in Germany. Size 1-280th.

486. Bursaria *flava*. *The pale yellow Bursaria.*—Body ovato-oblong, often acute at the posterior extremity; the mouth appears as a flat cavity immediately behind the round brow. Found in bog water. Size 1-140th to 1-96th.

487. Bursaria *nucleus*. *The almond-shaped Bursaria* has a small white ovate body, attenuated anteriorly; extremities convex. Found in Rana temporaria and esculenta. Size 1-240th.

488. Bursaria *ranarum*. *The frog Bursaria.*—Body ovate, lenticular, and compressed, sub-acute anteriorly; the back and belly carinated, and often truncated posteriorly; mouth inferior, situated near the frontal apex. Size 1-210th to 1-72nd.

489. Bursaria (?) *aurantiaca*. *The orange-coloured Bursaria.*—Body ovato-oblong, anterior obtuse, posterior acute; it has an ash-coloured spot near the mouth. Found amongst oscillatoria. Size 1-280th.

Genus CXIII. Spirostomum. *The snail Animalcules* have their bodies ciliated, the frontal region continuous, mouth spirally shaped, devoid of teeth, but with a tremulous flap. The cilii, which are disposed in rows, serve as organs of locomotion; those at the oblique frontal ridge are longer, and form, as in Stentor, a spiral wreath around the mouth; in S. ambiguum the brow and wreath are remarkably long. Digestive cells, to the number of ninety, have been demonstrated by coloured food, and its discharge

observed. They are hermaphrodite. A band-like thick gland is seen in S. virens, and a bead-like one in other species; the former likewise possess a large contractile bladder and green ova granules; but in S. ambiguum the latter are white. Self-division has not been observed, but Ehrenberg presumes a transverse mode exists.

490. SPIROSTOMUM *virens. The green Spirostomum.*—Body egg-shaped, depressed, truncated anteriorly, and rounded posteriorly. The back is arched, and the under side flat. The green ova granules are sometimes absent. (*Fig.* 296*.) Size 1-120th; ova 1-6000th.

491. SPIROSTOMUM *ambiguum* (*Leucophrys, Trichoda ambigua,* M.) *The worm-shaped Spirostomum.*—Body white, cylindrical, filiform, and pliant, obtuse anteriorly, and truncated posteriorly; the body extends very much beyond the mouth, forming an elongated frontal region or brow. The long vibrating cilii in front often appear like a proboscis, and were mistaken for such by Müller. The structure of this creature, especially the mouth, is remarkable, the latter being only one-fifth from the tail; thus the front or brow is very long, and the alimentary canal, first inflected forwards, returns along the body; from the mouth to the anterior or top of the brow runs a long ciliated furrow. *Figures* 297 and 298 represent this creature. In swimming they extend themselves, and are thus readily perceived by the naked eye. Found in ditches, among decaying oak leaves and rotten wood. Length 1-12th; ova 1-12000.

Genus CXIV. PHIALINA. *The bottle Animalcules* are characterized by having the frontal ciliated portion separated from the body by a constriction, forming a sort of

neck, body destitute of cilii, mouth lateral, and devoid of teeth. The motion of these creatures is produced by the vibration of this powerful wreath of cilii over the mouth. Ehrenberg says cilii may be present upon the surface of the body, as Müller saw them in Trichoda mellitea. The propagative organs are green or white ova granules, and a contractile bladder (perhaps two), situated posteriorly. Self-division probably transverse.

492. Phialina *vermicularis* (*Trichoda vermicularis*, M.) *The white Phialina.*—Body egg-shaped, attenuated anteriorly, neck very short. The white colour of this animalcule is caused by its ova. Found with lemna. Size 1-240th.

493. Phialina *viridis. The green Phialina.*—Body bottled-shaped, anterior part acute, the posterior gradually attenuated, neck very short. (*Fig.* 299.) Length 1-280th.

Genus CXV. Glaucoma. *The pearl Animalcules* are characterized by having the body covered with cilii, and a mouth provided with a tremulous flap, but no teeth. The reception and discharge of food, and the presence of digestive cells, indicate, according to Ehrenberg, the existence of an alimentary canal. The mouth, with its vibratory valve, is situated on the inferior side, near the middle. The reproductive organs are a large ovate gland, a star-like contractile bladder, and ova granules. Self-division transverse or longitudinal.

494. Glaucoma *scintillans* (*Cyclidium bulla*, M.) *The tremulous Glaucoma.*—Body elliptical or ovate, slightly depressed; ventricles large. The vibrating flap appears to be a semi-oval proboscis, with stiff margin. The cilii are seen by employing colour, or by pressing or drying them.

Figures 300, 301, and 302, represent different views of this creature; the latter shows it while undergoing transverse self-division. Found with Monads Size 1-280th.

Genus CXVI. Chilodon. *The lateral beaked Animalcules.*—Body ciliated, frontal region produced in the form of a broad membranaceous lip, expanded on one side, resembling a beak; the mouth, situated at its base, is furnished with a tabular fascicle of teeth. In one species a straight alimentary canal, with digestive cells attached to it, is seen; ova granules, and a contractile vesicle, are visible in three species, an oval gland in all; in one only has transverse and longitudinal self-division been observed, and in this the parts separated are so small that they may be considered as gemma or buds.

495. Chilodon *cucullus* (*Kolpoda cucullus*, M.) *The helmet-like Chilodon.*—This creature, represented in *figs.* 303 to 307, has a depressed oblong body, rounded at the ends, the frontal region advancing on the right side, Ehrenberg states he has often seen the straight alimentary canal, with its grape-like cells, filled with large Naviculae. Three contractile vesicles and a large oval gland near the middle have been observed. The circlet of teeth (*figures* 308 and 309) consists of little hard wand-like bodies; these the creature can separate so as to admit into its mouth large living bodies, after which it contracts or closes them. (See the *engravings.*) In swimming, or creeping upon the surface of conferva, the mouth is turned under or below. Its motion is gliding, and it does not revolve in swimming. When the water is coloured, the cilii may be easily perceived, and their disposition when it is dried. *Figs.* 305 and 306 exhibit it while undergoing longitudinal, and 307 trans-

verse, self-division. Found both in fresh and salt water. Size 1-1150th to 1-140th.

496. Chilodon *uncinatus*. *The hook Chilodon* has a depressed oblong body, rounded at the ends. The right side of the anterior part is produced, so as to appear like a hook or beak. Found in vegetable infusions. Size 1-430th.

497. Chilodon *aureus*. *The gold-coloured Chilodon* has an ovate, conical, turgid body, of a golden yellow colour, dilated and obtusely rostrated anteriorly, attenuated posteriorly. Size 1-140th.

498. Chilodon *ornatus*. *The adorned Chilodon* has an ovate sub-cylindrical body, of a golden yellow colour, equally rounded at both ends, slightly beaked; it has a bright violet spot. Size 1-180th.

Genus CVII. Nassula. *The wheel Animalcule.*—Body covered with cilii, turgid and prominent in front, but without the expansion or beak on one side; mouth provided with a circlet of teeth, in the form of a wheel (Nassa). Numerous polygastric cells are seen, and in two species the discharging orifice. Ehrenberg states that the existence of a new system of organs subservient to digestion becomes evident in this genus: these are of a violet colour, and probably biliary glands; one is present in Chilodon ornatus and chlamidodon, Bursaria vernalis, Trachelius meleagris, Amphileptus margaritifer, meleagris, and longicollis; they resemble the vesicular glands around the stomachs of the Rotatoria. The propagative system is double; two species have the ova granules, and all possess a large oval or spherical gland, and one or more contractile vesicles. Transverse self-division only has been observed.

499. Nassula *elegans. The elegant Nassula.*—Body cylindrical or oval, slightly attenuated in front, extremities very obtuse. It is white or greenish, spotted with violet vesicles; digestive cells, containing Chlamidomonas, or other food, may often be observed; from fifteen to twenty rows of cilii may be seen at one view. The animalcule swims backward and forward, turning upon its longitudinal axis. The mouth is easily perceived by the currents, when indigo is mixed with the water: it has a circlet containing twenty-six little wands or teeth, which can voluntarily diverge or converge anteriorly. When self-division ensues the large central gland is divided. *Figures* 310 and 311 represent this creature; the latter is a young one. Found with lemna and conferva. Length 1-140th to 1-120th.

500. Nassula *ornata. The adorned Nassula.*—Body ovate or globular, depressed, of a brownish-green colour, variegated with numerous violet vesicles. The posterior part of the body has a small excavation. Ehrenberg says there are from six to eight groups of vesicles, forming a wide circle round the mouth; these are filled with a violet coloured juice, which is discharged with the excrement, and appears like drops of oil, but soon mixes with and colours the water. Found amongst swimming clusters of oscillatoria by Ehrenberg. Size to 1-96th; ova 1-4800th.

501. Nassula *aurea. The golden-coloured Nassula.*—Body ovato-oblong, nearly cylindrical, very obtuse at the extremities. The special organs for digestive juice not distinct. Size 1-120th.

Family XVIII.—OPHRYOCERCINA.

The animalcules of this small family have no lorica; they possess an alimentary canal, with two distinct orifices, the anal one only being terminal. Although their motion is rapid, vibratile organs are only perceived near the mouth, but their long neck probably assists them in swimming, and indeed is alone sufficient for that purpose. Perhaps, remarks Ehrenberg, the body is covered with delicate cilii. Ova granules are seen in all the species, and a contractile vesicle in T. biceps. Neither self-division nor a development in clusters has been observed.

Genus CXVIII. Trachelocerca. *Swan-like animalcules.*

502. Trachelocerca *olor* (*Vibrio proteus cygnus, et olor,* M.) *The white Trachelocerca.* — Body spindle-shaped, neck simple, very long and flexible, dilated and ciliated at the mouth. This creature (see *figures* 317, 318, 319,) creeps at the bottom of the vessel containing it, and twines itself gracefully about conferva, or the roots of lemna, but swims awkwardly. It elongates and contracts its neck at pleasure, and is altogether an interesting subject for the microscope. Greatest length, 1-36th; length of body, 1-280th.

503. Trachelocerca *viridis. The green Trachelocerca.* —Body spindle-shaped, neck simple, very mobile, long, and dilated at the mouth, which has a ciliated lip. Found amongst lemna. Length 1-120th; contracted, 1-380th.

504. Trachelocerca *biceps. The double-headed Trichelocerca.*—Body spindle-shaped, white; neck long, forked, and having separated mouths. Length, 1-190th.

Family XIX. ASPIDISCINA.

The animalcules included in this family are distinguished from those in the preceding one by the presence of a shell, or lorica; they have a distinct alimentary canal with two orifices, the discharging one only being terminal; the lorica is a firm, very transparent, combustible little shield, somewhat resembling the shell which covers the back of a tortoise; it projects anteriorly a little before the body; long flexible bristle-like organs attached to the abdomen enable the animalcule to climb, while its delicate cilii near the mouth serve as swimming and purveying organs. Numerous stomach-cells have been filled with coloured food by Ehrenberg, who has also seen the discharge of matter posteriorly. In one species ova and an oval gland are seen; in both a contractile vesicle. Müller observed self-division, but mistook it for copulation. They are not developed in large masses.

Genus CXIX. Aspidisca. *The shield Animalcules.*

505. Aspidisca *lynceus* (*Trichoda lynceus*, M.) *The beaked Aspidisca.*—Lorica nearly circular, truncated at the posterior end, and formed into a hook or beak in front. This animalcule generally swims or creeps with its back underwards. The mouth has very delicate cilii; the body five or six bristles (styles) posteriorly, and from five to eight hooks anteriorly, resembling in this respect Euplotes or Stylonychia. A contractile vesicle near the mouth, and twenty digestive cells, have been seen. When burnt upon platina no traces remain. Found amongst duck-weed and conferva. Size 1-1000th to 1-576th.

506. Aspidisca *denticulata.* *The denticulated Aspidisca.*—Lorica nearly circular, ends rounded, left side truncated and denticulated; the back is arched, the abdomen flat, and its hooked bristles are only visible when climbing. *Plate* vii., *fig.* 321, is an under view; and *figures* 322 and 323 side views. Size 1-576th.

Family XX.—KOLPODEA.

Animalcules whose polygastric digestive apparatus is furnished with an alimentary canal, the orifices of which are not at opposite extremities of the body. They have no shell or lorica; they are furnished with cilii, disposed in longitudinal series, which are subservient to locomotion and purveyance. In all of them numerous digestive cells have been demonstrated by means of coloured food, as likewise both orifices of the alimentary canal; the digestive juice (bile) is colourless. The ova are scattered and numerous; in the genus Kolpoda expulsion of the ova has been seen. The male generative structure is of a double kind, and complete self-division is frequent, but no formation of clusters or gemmae is seen. A sensitive system is indicated in one genus (Ophryoglena) by the presence of a visual point.

The genera are disposed as follows:—

Eye absent.	Short protruding tongue.—Cilii	absent on the back	Kolpoda.
		present every where	Paramecium.
	No tongue	with tail and proboscis ..	Amphileptus.
		with tail, no proboscis ..	Uroleptus.
Eye present			Ophryoglena.

Genus CXX. Kolpoda. *The bosom Animalcules* are provided with a little tongue-like member, have their under surface furnished with cilii (none on the back), but have no eye. Their motion is not active, the cilii being few. The mouth, termination of the alimentary canal, and numerous polygastric cells, may be demonstrated in one

species by coloured food. The mouth and discharging orifice are both on the ventral surface, the former having a protruding tongue-like member. The propagative organs are delicate strings of ova, formed in a net-like manner, whose exclusion has been seen in one species; a bright contractile round vesicle is observable in two species, and in another species two vesicles or sexual bladders are present. A large round or oval gland in the centre of the body has been seen in two species. Transverse and longitudinal self-division has been noticed by several observers, and in K. cucullus a skin or envelope.

507. KOLPODA *cucullus* (M.) *The cap-like Kolpoda.*—Body turgid, slightly compressed; its form that of a kidney, often attenuated anteriorly. Ehrenberg states the mouth is closed by a little fleshy tongue; this is most distinctly seen in Paramecium aurelia. When the ova are deposited, a collapse of the body ensues, and hence a change of form. When very young they are difficult to distinguish from the Monads. *Plate* vii., *fig.* 324, represents the normal form of this species. *Fig.* 325 represents the animalcule depositing its ova in a net-like mass, and *figures* 326, 327, and 328, are three young animalcules, which resemble Trichoda pyriformis. Common in vegetable infusions. Size 1-1800th to 1-280th.

508. KOLPODA (?) *ren.* *The kidney-shaped Kolpoda* has an ovato-cylindrical body, kidney-shaped, and rounded at the ends. Found in river water. Size 1-288th.

509. KOLPODA (?) *cucullio* (M.) *The elliptical Kolpoda.*—Body compressed, plane, elliptical, slightly sinuated anteriorly. Ehrenberg remarks neither cilii or tongue-like member was observable by him: hence its generic situation is uncertain. Size 1-900th.

Genus CXXI. Paramecium. *The long Animalcules* are ciliated on all sides, possess a (wart-like) tongue-like process, but have no visual point. The cilii are disposed in longitudinal series, those near the mouth are sometimes longer than the others, and are alone subservient to locomotion, except in two doubtful species. In P. chrysalis the long oral cilii are remarkable. The digestive cells are numerous, amounting to more than a hundred; they are berry-like, and arranged along the alimentary canal, which is curved: in five species they have been demonstrated by artificial means, in a sixth by its usual green food. The ova in two species are seen as a granular mass. In all, except one species, male organs are visible. The curious star-like contractile vesicle in the larger species is highly interesting, when physiologically considered, as are also the little black bodies seen in P. aurelia. In four species complete self-division, transverse and longitudinal, has been observed alternately.

510. Paramecium *aurelia* (M.) *The slipper Animalcule* has a club-shaped cylindrical body, slightly attenuated anteriorly. An oblique longitudinal fold borders upon the very receding mouth. Ehrenberg states that he has seen small dark crystalline bodies abundant in the frontal region, which he conceives are indications of the presence of nervous matter, as such crystalline bodies often accompany it. These creatures appear to have the sense of taste; and among the same group some individuals prefer one kind of food, and others another. This interesting fact may be observed by mixing blue and red colours together, when some will feed upon the former, others upon the latter, as indicated by the colour of the digestive cells; in

some the cells have a violet hue. These animalcules, fed with colour, may be dried upon glass or mica, and thus rendered permanent. The rays of the star-like vesicle Ehrenberg considers as a *ductus spermatici*, which is long, and enters the ovarium at many points. The expulsion of ova has frequently been observed. The colour of these animalcules, when bearing ova, is white by reflected light, and yellow by transmitted, hence the names "gold and silver little fishes," so often applied to them by Joblot and others; those devoid of ova are colourless. The cilii are best seen when the water is coloured; there are from twenty-six to fifty-two longitudinal rows along each side of the body; in some rows Ehrenberg counted from sixty to seventy cilii, which gives 3640 organs of locomotion; each cilium is placed upon a sort of little knot. *Fig.* 329 represents an animalcule dried from clear water; *fig.* 330 is a view of a creature feeding upon indigo, which latter indicates the currents produced by its cilia; *fig.* 332 is an ideal view, to shew the structure of the nutritive organs, as stated by Ehrenberg; *fig.* 331 is a young specimen of the normal shape, hence not produced by self-division. This species is abundant in vegetable infusions, and increases so rapidly in stagnant waters, both by ova and self-division, that some persons have thought they were produced spontaneously from elementary primal matter. Size 1-120th to 1-96th.

511. PARAMECIUM *caudatum. The tailed Paramecium.*—Body spindle-shaped, obtuse anteriorly, but attenuated posteriorly. Not found in infusions, but in ponds amongst decayed sedge leaves and conferva. Size 1-120th.

512. PARAMECIUM *chrysalis* (M.) *The chrysalis Pa-*

ramecium.—Body oblong and cylindrical, equally rounded at both ends, cilii about the mouth very long. This species, like P. aurelia, is often developed in such vast myriads that the water has a milk-like hue, the animalcules swarming like gnats, the masses ascending or descending in the fluid: this appearance may be produced by slightly shaking the water. Found in infusions and in salt water. Size 1-240th to 1-190th.

513. Paramecium *kolpoda* (*Kolpoda ren*, M.) *The bosom Paramecium.*—Body ovate, slightly compressed, ends obtuse, the anterior attenuated and slightly bent like a hook. Found especially in infusions of Urtica droica. Size 1-240th.

514. Paramecium (?) *Sinaiticum. The Paramecium of Sinai.*—Body elliptical, compressed, the back and under side carinated; frontal cilii indistinct. Found, amongst conferva, in a brook at Mount Sinai. Size 1-288th.

515. Paramecium (?) *ovatum. The egg-shaped Paramecium.*—Body ovate, turgid, anterior attenuated and rounded. Found in stagnant river water. Size 1-288th.

516. Paramecium *compressum* (*Paramecium aurelia*, M.) *The flat Paramecium.*—Body elliptical or reniform, compressed. It has an oblique wreath of long cilii reaching to the middle, where the mouth, with its slight tongue-like process, is situated. Found in the river muscle (Mya). Size 1-240th to 1-210th.

517. Paramecium *milium* (*Cyclidium milium*, M.) *The millet Paramecium.*—Body small, oblong, trilateral, rounded equally at the ends. In coloured water the body is seen vibrating. Size 1-1150th.

Genus CXXII. Amphileptus. *The double-necked*

Animalcules have neither tongue-like process or eye, but are provided with a proboscis and tail. In three species the organs of locomotion are numerous cilii disposed in longitudinal series; in one, cilii are not visible, but in this the flexible attenuated extremities of the body serve the office. In some, the tail (foot) and proboscis (brow) are rudimentary. In five species numerous digestive cells, filled with food, may be seen; in seven the mouth is distinct; and in five of them a discharging opening. All have a colourless digestive juice, except A. margaritifer, in which it is pale rose-red. Ova granules are observable in seven species, which in one are green, in the others whitish. In four species a contractile vesicle is seen; in three sexual glands, which in two are globular, double, and moniliform; in the third self-division has been observed in one species, both as transverse and longitudinal, and in another as transverse only. The figures of this genus were engraved before I discovered Dr. Ehrenberg had not arranged his illustrations according to the classification.

518. Amphileptus *anser* (*Vibrio anser et cygnus*, M.) *The white Amphileptus.*—Body turgid, spindle-shaped, proboscis obtuse, same length as body, tail short and acute. The neck-like proboscis is truly a brow or upper lip, the mouth being at the base. Ehrenberg thinks he has seen the anal opening upon the dorsal surface, near the tail. The motion of the body is slow, but that of the proboscis more active. *Figures* 312, 313, represent two views of this creature. Found amongst dead sedge leaves, &c. Size 1-120th.

519. Amphileptus *margaritifer. The pearl Amphileptus.*—Body white, slender, spindle shaped; proboscis

length of the body, acute like the tail, which is short. The most striking features are the swollen margin of the mouth, and necklace-like series of vesicles disposed along the body. It feeds upon green Monads, like the preceding species. Cilii are absent in Dr. Ehrenberg's figures. Found amongst colonies of Vorticella, &c. Size 1-72nd.

520. AMPHILEPTUS *moniliger*. *The chain Amphileptus.*—Body turgid, ample, white; proboscis and tail short; it has a necklace-like gland. Found amongst duck-weed. Size 1-96th to 1-72nd.

521. AMPHILEPTUS *viridis*. *The green Amphileptus.*—Body turgid, spindle-shaped, and of a green colour; proboscis and tail short and transparent. Found amongst Lemna minor. Size 1-120th to 1-96th.

522. AMPHILEPTUS *fasciola* (*Vibrio anas fasciola et intermedius. Paramecium fasciola*, M.) *The fillet Amphileptus.*—Body white, depressed, linear, lanceolate, convex above, flat beneath. When viewed from above, from ten to twelve longitudinal series of delicate cilii may be seen, and in the middle of the body two round glands, posterior to which is a sexual vesicle, and ova granules between the digestive cells. *Figures* 314, 315, 316 represent three views of this creature. Found in infusions. Size 1-720th to 1-144th.

523. AMPHILEPTUS *meleagris* (*Kolpoda*, M.) *The spotted Amphileptus.*—Body large, compressed, membranous, broadly lanceolate in shape, with the crest of the back denticulated. The colour of this interesting animalcule is white. On the under side there is, more or less distinct, a row of eight to ten bright colourless spots (juice bladders). Found with lemna. Size 1-72d.

524. AMPHILEPTUS *longicollis* (*Kolpoda ochrea, Trichoda felis,* M.) *The long-necked Amphileptus.*—Body dilated, and turgid posteriorly, attenuated and elongated anteriorly, like a sword. Found amongst lemna. Size 1-120th to 1-96th.

525. AMPHILEPTUS (?) *papillosus. The fringed Amphileptus.*—Body depressed, lanceolate, fringed with papillæ, tail and proboscis smooth. Found amongst conferva. Size 1-600th to 1-430th.

Genus CXXIII. UROLEPTUS. *The train Animalcules* have neither eye, tongue-like process, nor proboscis, but are provided with a tail. Locomotion is effected by cilii; in three species these are disposed in rows. The polygastric apparatus has been demonstrated by coloured food in two species, the mouth observed in all of them, but the discharging orifice has not been satisfactorily determined. Green coloured ova granules are evident in two species, but no male organs.

526. UROLEPTUS *piscis* (*Trichoda piscis,* M.) *The little fish Uroleptus.*—Body like an elongated top, the posterior part gradually attenuated, forming a thick tail; ova greenish. The body is covered with cilii, those at the mouth being largest. Found, in February and March, amongst the floccose brown coat upon dead sedge leaves, along with Chlamidomonas and Cryptomonas. (Hampstead ponds.) Size 1-288th to 1-44th.

527. UROLEPTUS *musculus* (*Trichoda musculus,* M.) *The water-mouse Uroleptus.*—Body white, cylindrical, pear-shaped, incrassated towards the posterior, where it abruptly terminates in a tail, as seen in the engraving, *figure* 333, *plate* vii. The movement is rolling. It is in-

active and (stiff). In swimming the body revolves. Found with oscillatoria. Size 1-220th.

528. UROLEPTUS *hospes.* *The stranger or guest Uroleptus.*—Body greenish, ovato-oblong, and turbinate in shape, anterior obliquely truncated and excavated; the posterior terminated by a styliform acute tail. Found in the cells of frog and snail spawn. Size 1-240th.

529. UROLEPTUS (?) *lamella.*—Body transparent, linear, lanceolate, depressed, flat, very thin. Found in infusions. Size 1-220th.

530. UROLEPTUS *filum* (*Enchelys caudata,* M.) *The thread Uroleptus.*—Body white, filiform, cylindrical, rounded anteriorly, attenuated posteriorly, forming a straight long tail. Found in stagnant spring water, &c. Size 1-48th.

Genus CXXIV. OPHRYOGLENA derives its name from the animalcules possessing an eye anteriorly, and having a ciliated body. Locomotion is effected by numerous longitudinal series of cilii. Their numerous digestive cells are often filled with Naviculae, and in one species this structure has been demonstrated by indigo. The mouth is situated in a cavity beneath the brow, and the discharging orifice upon the dorsal surface, at the base of their little tail. The ova granules are brown in one species, black in another, and yellow in the third. A large central gland exists in one species, and contractile sexual vesicles in the others; transverse and longitudinal self-division has been observed in one species. A system of sensation is indicated by the presence of a large red or black visual organ, always present on the frontal region.

531. Ophryoglena *atra* (*Leucophra mamilla*, M.) *The black Ophryoglena.*—Body blackish, compressed, acute posteriorly. The cilii are white, the eye black, and situated near the frontal dorsal margin. The mouth aperture forms a funnel-shaped cavity, commencing immediately beneath the brow; within this cavity Ehrenberg thinks he has lately seen an oval bright gland. The white cilii appear like silver fringe, especially those anterior. Found in turf hollows. Size 1-180th.

532. Ophryoglena *acuminata. The tailed Ophryoglena.*—Body brown-coloured, ovate, and compressed, tail short and acute, eye red. The brow projects beyond the mouth about the length of the body, or, in other words, is situated about the middle. *Figures* 334, 335, are two views of the same animalcule. Found in turf hollows. Size 1-180th.

533. Ophryoglena *flavicans. The yellow Ophryoglena.*—Body yellow, turgid, ovate, attenuated and rounded posteriorly, eye red; the cilii near the mouth longer than in the preceding species; Ehrenberg counted from twelve to sixteen rows at one view. Found in turf hollows. Size 1-144th.

Family XXI.—OXYTRICHINA.

This family contains all polygastric animalcules which possess an alimentary canal with two separate orifices, neither of them situated at the extremities—which have no lorica, but are provided with setæ, vibratile cilii, and non-vibratile styles or uncini. These locomotive organs are variously situated, and render the creature active. The polygastric cells, disposed upon an alimentary tube, have been demonstrated by Ehrenberg, and in Ceratidium only are indistinct. The mouth and discharging orifice, ova-like granules (at certain periods), and male organs (glands and vesicles), are each seen in four genera. Complete transverse and longitudinal self-division is observed in three genera, but no gemmae or buds. Eyes have not been detected.

Cilii and setae—no styles or uncini	brow without horns	Oxytricha.
	brow with horns	Ceratidium.
Styles, or uncini, or both	with uncini—no styles	Kerona.
	with styles—no uncini	Urostyla.
	with styles and uncini	Stylonychia.

Genus CXXV. Oxytricha. *The hatchet Animalcules* are destitute of styles and uncini, and unprovided with horns. The locomotive organs are cilii and setæ, though the latter resemble rigid hairs; their movements are forwards and backwards, often by impulses, creeping, swimming, and climbing; all locomotion is effected by the vibration of the former. In all the species polygastric cells are evident, in five ova-like granules, in four male glands, and in five round sexual vesicles. Transverse and longitudinal di-

vision is observed in O. lepus and pelionella; longitudinal only in O. cicada, and perhaps O. pullaster.

534. Oxytricha *rubra* (*Trichoda piscis et patens,* M.) *The red Oxytricha.*—Body of a brick-red colour, linear in shape, plane on the under side, and equally rounded at the ends. Found in sea water. Size 1-140th.

535. Oxytricha *pellionella* (*Trichoda pellionella,* M.) *The furred Oxytricha.*—Body white, smooth, slightly depressed, equally rounded at both ends, often broader in the middle, head not separate, mouth ciliated, and the tail provided with setæ. Each animalcule has two oval male glands, and between them a single round sexual vesicle. When self-division commences four glands are developed, and then the vesicle divides. Ehrenberg counted ten cilii anteriorly, and four or five setæ posteriorly; the discharge is at the base of the setæ. Found in infusions. Size 1-720th to 1-280th.

536. Oxytricha *caudata.* *The tailed Oxytricha* is smooth, white, linear, lanceolate in shape, rounded anteriorly, the posterior attenuated in the form of a tail, which is provided with setæ. Found in fresh water and sea water. Size 1-576th to 1-120th.

537. Oxytricha *platystoma.* *The broad-mouthed Oxytricha.*—Body white, ovato-oblong, under side flat, provided with setæ upon the margin, the mouth large and ciliated. It swims with a revolving and vacillating motion, also often upon the back. It creeps upon water plants. Found in standing bog water. Size 1-240th.

538. Oxytricha *gibba* (*Trichoda gibba et fœta,* M.) *The gibbous Oxytricha.*—Body white, lanceolate, ends obtuse, middle enlarged, under side flat and furnished with

two series of setæ, and a large round mouth. This species resembles O. pelionella, but is distinguished by the setæ, the two or three contractile vesicles, and sexual glands. This creature is active, and runs nimbly along aquatic plants in fresh and brackish water. *Figure* 336 is an under view, 337 a side view. Size 1-240th.

539. OXYTRICHA *pullaster* (*Trichoda pullaster, Kerona pullaster*, M.) *The water-hen Oxytricha.*—Body whitish, lanceolate, ends obtuse; ventral surface naked at the middle; the head, indicated by a constriction, is hairy, like the tail. The mouth is a narrow fossa. Found in water vessels and infusions. Size 1-430th.

540. OXYTRICHA *cicada* (*Trichoda cicada*, M.) *The water-cricket Oxytricha.*—Body ovate or almost hemispherical, back furrowed and notched, under surface flat. Found upon the surface of stagnant water. Size 1-1440th to 1-860th.

541. OXYTRICHA *lepus. The water-hare Oxytricha.*—Body whitish, elliptical, smooth, flat, ciliated anteriorly, and provided with setæ posteriorly; the mouth and discharging orifices not distinct; Ehrenberg has not seen the male generative apparatus. Found in standing water. Size 1-540th to 1-96th.

Genus CXXVI. CERATIDIUM. *The horned Animalcules* have cilii, horns on the frontal region, but no styles or uncini. But little of their organization is known, and therefore the situation of the species is uncertain. It requires a power not less than 350 to exhibit it.

542. CERATIDIUM *cuneatum. The wedge-shaped Ceratidium.*—Body triangular, front truncated, as also the two horns, upper side smooth. Ehrenberg found this whitish

animalcule in 1820 amongst conferva, but has not lately seen it. It vibrates, runs, and climbs quickly. *Figs.* 338, 339, represent two views of this animalcule. Size 1-430th.

Genus CXXVII. KERONA. *The claw Animalcules* are provided with cilii and uncini, but not with styles. The body is ciliated, besides which, upon the under surface, there are claws, and perhaps setæ. Numerous digestive cells indicate the polygastric structure; the mouth, and probably the anal spot, are upon the ventral surface. The propagative system is double, consisting of ova glands, and a contractile vesicle. Self-division has not been observed.

543. KERONA *polyporum. The oval polypi Kerona.*—Body whitish, depressed, elliptical, and reniform; it has a series of cilii around the frontal region, produced from below the mouth; Ehrenberg counted above forty digestive cells, many of them filled with brownish (half-digested green) Monads. Between the cells are ova granules. *Fig.* 340 is a back view, and 341 a side view, climbing. Parasitic on Hydra vulgaris and polypi. (See *Microscopic Cabinet, plate* vii.) The latter die when infested with them. Size 1-144th.

Genus CXXVIII. UROSTYLA. The *style Animalcules* are provided with cilii and styles, but destitute of uncini; the cilii are thickly disposed in numerous series, those near the mouth being longest. On the ventral surface, at the posterior end, is a small cleft, provided with non-vibratile setæ. The numerous digestive cells receive colour and large bodies; a gland, a contractile sexual vesicle, and delicate granulated ova, represent the propagative system. Transverse self-division also has been observed.

544. UROSTYLA *grandis*. *The great Urostyla.*—Body white, semi-cylindrical, rounded at the ends, anterior slightly enlarged, hence it appears club-shaped; styles short, mouth cleft, large, 1-4th to 1-3rd the length of the body; it has long cilii on both sides; the discharging orifice has from five to eight little styles on the left side only; the stomach juice is colourless. The young animalcules are flatter than the old ones. *Fig.* 342 represents an under view with glands, vesicle, and the cells filled with Bacillaria and coloured matter. Currents produced by the vibration of the cilii about the mouth are also indicated in the drawing. Found on slimy dead sedge leaves. Size 1-144th to 1-96th.

Genus CXXIX. STYLONYCHIA. *The armed Animalcules* are ciliated, and armed with styles and uncini. These organs of locomotion are variously disposed. In one species the course of the alimentary canal, with its numerous digestive cells, has been seen; in the others coloured food is received in the cells; a thick granulated ova cluster exists in all the species, in two of them two glands, and in four, contractile vesicles. Transverse and longitudinal self-division in two species, transverse only in a third, and in S. pustulata, the formation of gemmae, is seen.

545. STYLONYCHIA *mytilus* (*Trichoda mytilus, Kerona mytilus*, M.) *The muscle Animalcule.*—Body white, flat, oblong, slightly constricted in the middle, obliquely dilated anteriorly in the form of a muscle. The extremities are so transparent that they give it the appearance of being covered with a shield, but they are soft, flexible, and furnished with cilii. The stomach juice is colourless, the

middle of the body is sometimes filled with delicate white granules (ova). This animalcule generally has a peculiar thrusting forward and back movement, but can climb, run, and swim nimbly, usually with the back undermost. Dr. Ehrenberg found a single animalcule lived nine days: during the first twenty-four hours it formed, by transverse self-division, into three animals; these in twenty-four hours more formed two, in the same manner; so that, by self-division only (without ova), they increase three or four-fold in twenty-four hours, and thus a million may be produced from a single animalcule in ten days. An abundant supply of food favours self-division. Found in infusions and amongst oscillatoria. Size 1-240th to 1-96th.

546. Stylonychia *pustulata* (*Trichoda acarus*, M.) *The flounder Animalcule* has a white body, which is turbid, elliptical in shape, attenuated at both ends, and having a band of uncini at the middle of the belly. Ehrenberg has seen transverse and longitudinal division, and the growth of gemmae. Found in infusions. Size 1-144th; ova granules 1-24000th.

547. Stylonychia *silurus* (*Trichoda silurus, Kerona silurus, Hymentopus lava, &c.*, M.) Body small, white, in the form of a muscle, cilii and uncini rather long. Found in fresh water. Size 1-280th.

548. Stylonychia *appendiculata*. *The spur Animalcule.*—Body elliptical, white, small, and flat; cilii and styles long, the setæ disposed obliquely in fascicles. Found in fresh water. Size 1-280th.

549. Stylonychia *histrio* (*Paramecium histrio, Kerona histrio*, M.) *The mask Stylonychia.*—Body elliptical, white, middle slightly turgid, anterior finished with a

cluster of uncini; no setæ. Dr. Ehrenberg states the absence of the three posterior setæ in this and the following species is remarkable, as the others possess them. Found amongst conferva. Size 1-280th.

550. STYLONYCHIA *lanceolata*. *The lancet Stylonychia.*—Body pale greenish, lanceolate in shape, extremities equally obtuse, under side flat; it has uncini in a cluster near the mouth, but no styles. Ehrenberg saw in one specimen a simple contractile vesicle on the left side, below the mouth, and near it a large oval gland. Green Monads and Bacillaria may be seen in this voracious animal, surrounded with colourless stomach juice. *Fig.* 343 represents an under view, and *fig.* 344 the side view of another. Found amongst conferva. Size 1-144th to 1-120th.

Family XXII.—EUPLOTA

Comprehends polygastric animalcules having a lorica and alimentary canal, with two separate orifices, neither of which are terminal. They possess powerful organs of locomotion, similar to those of the preceding family.

This family resembles in many respects the genus Asellus of the Entomostracia, whose organization is so highly developed: hence this family very properly closes the grand division Polygastrica. Organs subservient to nutrition are distinctly elicited in three genera—one is marked by having a cylinder of wand-like teeth, and a beautiful rose-coloured digestive juice, like the genus Nassula. The propagative apparatus is double in three genera, ova granules are found in two, male glands in two, a contractile vesicle in three; self-division, transverse and longitudinal, is observed in one, but gemmae are not produced. One form is green, the others are colourless and whitish.

This family comprises the following genera:—

With cilii—no styles	teeth absent	head distinguished from the body	Discocephalus.
		head not distinguished from the body .	Himantophorus.
	teeth present	....	Chlamidodon.
With cilii, claws, and styles		....	Euplotes.

Genus CXXX. Discocephalus. *The disc-headed Animalcules* have neither styles nor teeth, but possess uncini, and have the head distinguished from the body (capitate). The organization is unknown, only the non-vibratile uncinated locomotive organs having been specially observed.

551. Discocephalus *rotatorius. The vibrating Discocephalus.*—Body transparent, flat, head smaller than the body, both rounded. *Fig.* 345 is an under, and 346 a side view. Found in the Red Sea. Size 1-380th.

Genus CXXXI. Himantophorus. *The whip-footed Animalcules* are distinguished by the absence of styles and teeth, by having numerous uncini, and not having the head distinct from the body. The long bent hooks, generally in pairs, appear like a broad band upon the under side, serving as organs of locomotion; near them is a row of cilii, extending from the mouth to the middle. The mouth, discharging orifice, and numerous digestive cells, are distinct. At the posterior margin is a large contractile vesicle; between the row of cilii and margin on the right is a series of glandular spots. Self-division has not been observed.

552. Himantophorus *charon* (M.)—Body transparent, flat, elliptical, anterior slightly truncated obliquely, cilii short, uncini long and slender. The mouth commences anteriorly at the lower angle of the triangular bright spot, but the true œsophagal opening appears to be at the end of the row of cilii within the curved lorica; the posterior alimentary opening is nearly at the base of the last cluster of four to six comb-like uncini, which supply the place of styles. *Fig.* 347 is a side, and 348 an under view. Found in water vessels that have stood some time. Size 1-180th.

Genus CXXXII. Chlamidodon. *The toothed Animalcules* possess cilii and teeth at the mouth, but no styles or uncini; an oval transparent lorica or shield covers the back, and projects around it; a margin of cilii surrounds the

body, these are longer near the brow; short climbing setæ probably exist posteriorly, between the cilii. Polygastric cells are distinct, as also vesicles containing a beautiful rose-coloured digestive fluid; the mouth has a hollow cylinder of wand-like teeth. Minute green ova granules (?) and a large oval bright central gland represent the propagative organs. Self-division unknown.

553. CHLAMIDODON *mnemosyne*. *The rose Chlamidodon.*—Body flat, elliptical, sometimes dilated anteriorly, as shewn at *fig.* 349. It is of a clear green or hyaline hue, with brilliant rose-coloured vesicles; delicate longitudinal lines are seen upon the surface of the animalcule, and appear to be on the lorica. Ehrenberg counted sixteen wand-like teeth disposed cylindrically. The movement is quick and powerful, like Euplotes. Found with Zostera and Scytosipyon. Size 1-570th.

Genus CXXXIII. EUPLOTES. *The skiff-like or boat Animalcules* possess cilii, styles, and uncini, which are powerful locomotive instruments, but no teeth. Polygastric cells have been filled in four species with coloured food; in the others bright vesicles evidence them; the termination of the alimentary canal is indicated in one species by the discharge, in the rest by the projecting little shield; the digestive juice is colourless; the propagative organs are probably double in seven species, in one completely so. Ova, which are white, are seen in four species; oval or round simple glands exist in three; a single contractile vesicle in five; and in a sixth two vesicles are observed. Self-division, transverse and longitudinal, has been observed in one species, and transverse only in two or four others.

554. EUPLOTES *patella. The dish-like Euplotes.*—Lorica large, nearly circular, slightly truncated anteriorly, the margin transparent, broad, the back elevated, gibbous, and covered with a few delicate smooth striæ. The mouth is ciliated on each side, the œsophagus is near the side, lower than the middle, the discharging orifice behind the basis of the styles. Found with lemna. Size 1-280th.

555. EUPLOTES *charon* (*Trichoda charon*, M.) *The pearled Euplotes, or the little Charon.*—Lorica small, ovato-elliptical, slightly truncated anteriorly, and having granulated striæ on the back; twenty to forty cilii were counted by Ehrenberg, but no setæ; white ova, propagative glands, and a contractile vesicle, have been seen. *Figures* 350 to 353 represent different views. Found in standing water and infusions. Size 1-1150th to 1-280th.

556. EUPLOTES *striatus. The striated Euplotes.*—Lorica oblong, elliptical, slightly truncated anteriorly, uncini only upon the posterior part of the body; there are four smooth striæ upon the back. Found in sea water. Size 1-240th.

557. EUPLOTES *appendiculatus. The spurred Euplotes.*—Lorica ovato-oblong, ends rounded, provided with oblique styles, and four straight setæ upon the posterior part of the body. Found in sea water. Size 1-240th.

558. EUPLOTES *truncatus. The truncated Euplotes.*—Lorica oblong, with smooth striæ, unequally truncated, and notched anteriorly. It has setæ and numerous uncini. The styles are straight. Found in sea water. Size 1-240th.

559. EUPLOTES *monostylus. The tailed Euplotes.*—Lorica elliptical, ends rounded, no striæ. It has a single

style, like a tail, but no uncini. Found in sea water. Size 1-400th.

560. EUPLOTES *aculeatus. The spinous Euplotes.*—Lorica oblong, nearly square, ends rounded; it has two crests upon the back, one bearing a little spine in the middle. Found in sea water. Size 1-430th.

561. EUPLOTES *turritus. The Chinese cap Euplotes.*—Lorica smooth, nearly circular; it has a long erect spine on the centre of the back. Size 1-600th to 1-430th.

562. EUPLOTES *cimex* (*Trichoda cimex*, M.) *The smooth Euplotes.*—Lorica oblong, elliptical, and smooth. This creature is provided with cilii, styles, and uncini. Found in sea water. Size 1-430th.

Class II.—ROTATORIA.

Those infusorial animalcules which are included under the great division Rotatoria are distinguished by their being destitute of a true nervous system and of vascular pulsation; by their possessing a simple tubular alimentary canal, a definite form of body (that is, not alterable by the formation of gemmae, or spontaneous division, as in the Polygastrica), being androgynous, or hermaphrodite, provided with rotatory organs, and, though destitute of true articulated feet, often have a single false foot, or pediform process.

The magnifying power most useful for the examination of the Rotatoria is 250; and with a power of 400 times, all that has been discovered in their internal organization (except in one or two cases) may be seen.

The following table represents the analysis of the class Rotatoria into families:—

With a simple continuous wreath of cilii. (Monotrocha.)	margin of cilii-wreath entire. *Holotrocha.*	illoricated	Icthydina.
		loricated	Oecistina.
	margin of cilii-wreath lobed or notched. *Schizotrocha.*	illoricated	Megalotrochaea.
		loricated	Floscularia.
With a compound or divided wreath of cilii. (Sorotrocha.)	with the cilii-wreath divided into several series. *Polytrocha.*	illoricated	Hydatinea.
		loricated	Euchlanidota.
	with the cilii-wreath divided into two series. *Zygotrocha.*	illoricated	Philodinaea.
		loricated	Brachionaea.

FAMILY XXIII.—ICHTHYDINA

Contains all those rotatory animalcules which possess a single continuous rotatory organ, not cut or lobed at the margin. They are destitute of lorica or shell. In Ptygura and Glenophora their wheel-like organ is in the form of a circle, and serves for the purposes of locomotion; in the other genera it is band-like, long, elliptical, and upon the ventral surface. A forked foot-like process is met with in Chaetonotus and Ichthydium, and a simple one in the others. A simple conical alimentary canal, with a long thin œsophagus, without teeth (?), is seen in Ichthydium and Chaetonotus; Glenophora has a short œsophagal portion, and two single teeth, and Ptygura an elongated stomach and three teeth. Pancreatic glands are seen only in Chaetonotus and Ptygura; neither cœcum nor gall-ducts are visible in any of the genera. The male reproductive organs have not been observed in any form, and the female ones consist, in two genera, of a large ovarium, with a few large ova. The two red frontal eyes, seen in Glenophora, are indications of the existence of a nervous system, and the bristly hairiness of the back of Chaetonotus is worthy of remembrance.

This family comprises the following genera:—

Eyes absent	hair absent	with a simple truncated tail-like foot (*Pseudopodium*)	Ptygura.
		with a forked tail-like foot	Ichthydium.
	hair (bristle-like) present		Chaetonotus.
Eyes present (two frontal)			Glenophora.

Genus CXXXIV. PTYGURA. *The wrinkled-tail Animalcules* are destitute of eyes and hair, but have a simple,

truncated, cylindrical, false foot. The rotatory organ is also simple, and nearly circular. Numerous teeth-like bodies, adhering to the bulb of the œsophagus, two pancreatic glands, a small narrow œsophagus, an elongated stomach, and a globular-like rectum, are the apparatus of nutrition. An ovarium and a contractile vesicle have been observed, but neither longitudinal muscles nor visual organs, although carefully sought for.

563. Ptygura *melicerta. The wrinkled-tail Ptygura.*—Transparent, body cylindrical, club-shaped, turgid anteriorly, with two little curved horns at the mouth, and a single short tube at the neck (?). The tail-like foot always remains transversely folded (wrinkled), as seen in *fig.* 354, *plate* vii., which represents the under side. When swimming, a ring-like simple vibratile organ is thrust out with a lateral notch. The two jaw-like parts of the œsophagal bulb have numerous teeth, as represented at *fig.* 355. Size 1-140th.

Genus CXXXV. Ichthydium. *The ciliated fish Animalcules* have a cleft or forked foot-like tail, no eyes or hair; currents at the mouth, and along the ventral side, indicate the existence of a vibratile organ, which not only serves for swimming, but likewise for creeping. A long œsophagus, a thick simple conical alimentary canal, and sometimes a large single ovum, comprise our knowledge of their organization. It is probable that a cylinder of little wand-like teeth exists.

564. Ichthydium *podura* (*Cercaria podura*, M.) *The ciliated Ichthydium.*—Body straight, oblong, often slightly constricted anteriorly, which is turgid, and sometimes three-lobed. It is colourless or whitish, but during repletion

sometimes appears yellowish; the ventral surface is flat and ciliated, the dorsal arched and smooth. The large dark ovum has been seen by Ehrenberg. It seldom swims, but mostly creeps. *Fig.* 356 exhibits a full-grown animalcule (ventral side). Found among conferva and oscillatoria. Length 1-440th to 1-140th.

Genus CXXXVI. Chaetonotus. *The brushed fish-Animalcules* have hairs upon their dorsal surface, possess a forked tail, but no eyes. Locomotion is performed by a double row of cilii upon the ventral surface, which forms a band-like rotatory organ. The nutritive organs consist of a tubular mouth, probably provided with a cylinder of teeth, a long thin œsophagus, and a long conical stomach (Trachelogastricum), upon whose upper thick end (in the large species), two semi-globular glands are seen; at certain periods from one to three large single ova are formed posteriorly, but the ovarium in which they are developed has not been directly observed; male reproductive organs unknown. They are sluggish in their movements, except in creeping; they rarely swim.

565. Chaetonotus *maximus. The large Chaetonotus.*— Body elongated, slightly constricted anteriorly, turgid and obtusely three-lobed; the hairs upon the back are short and equal. From the latest observations, Ehrenberg states the mouth to possess teeth, of which he has counted more than eight; he once saw the exclusion of ova immediately over the hinder foot-like tail. It creeps but slowly. Size 1-216th to 1-120th.

566. Chaetonotus *larus* (*Trichoda acarus, anas et larus,* M.) *The gull Chaetonotus.* — Body elongated, slightly constricted anteriorly, where it is turgid and ob-

tusely triangular; the posterior hair on the dorsal surface is longest. Ehrenberg has seen only one large ovum; he states that the bodies of those bearing ova were thick posteriorly, though, under other circumstances, the head is broadest. It appears to have eight teeth. Pancreatic glands are unknown; the dorsal hairs, which are arranged in longitudinal rows, destroy the transparency of the body. *Fig.* 357 is a dorsal, and *fig.* 358 a side view. Ova 1-3rd the length of the body. Found in muddy water. Size 1-720th.

567. CHAETONOTUS *brevis. The short Chaetonotus.*— Body ovato-oblong, slightly constricted near the turgid front, dorsal hairs few, the posterior ones longest, ova small. Size 1-430th.

Genus CXXXVII. GLENOPHORA. *The eye Animalcule* is characterized (as its name imports) by the presence of two eyes, placed anteriorly; it has a frontal circular rotatory organ, and a truncated bifid tail, or false foot. The alimentary canal is short, thick, and conical; it sometimes contains green matter. The two protruding forcep-like bodies, in the middle of the rotatory organ, may, says Dr. Ehrenberg, be considered teeth; pancreatic glands are indicated by knot-like turbid bodies. The eyes are sharply circumscribed, and situated at the frontal region; a respiratory tube is unknown.

568. GLENOPHORA *trochus. The top Glenophora.*— Body ovato-conical, truncated, and turgid anteriorly, attenuated posteriorly into a false foot; the eyes are blackish. It swims quickly, like a Trichodina or free Vorticella. The genera Monolabis and Microcodon have similar forms. *Figures* 359, 360, represent two animalcules, the latter having the stomach filled with a green substance. Size 1-570th.

Family XXIV.—OECISTINA

Comprise infusory animalcules which have a single rotatory organ entire at the margin, and whose bodies have an envelope, or lorica. This family contains only two species; they possess an organization more developed than any we have yet described. Locomotive organs, with internal muscles, says Dr. Ehrenberg, and a tail-foot, not pincer-like, nutritive organs, with a chewing apparatus, consisting of teeth in rows, two pancreatic glands, as well as the development and expulsion of ova, are observed in both. Male organs, unknown vessels, two filiform tremulous organs (gills), and nervous fibrillæ, along with ganglia, are elicited in Conochilus, and red visual points in both genera. They are thus tabulated: —

Lorica	special and distinct to each single animalcule	Oecistes.
	conglomerate, or common to many single animalcules	Conochilus.

Genus CXXXVIII. Oecistes. *The sheathed little fish Animalcules* are characterized by each animalcule having a separate lorica. They have two eyes, situated anteriorly, which it is curious to notice become effaced as age advances. A simple wreath of cilii is observed in the frontal region of the body; the long tail-like foot has internal longitudinal muscles. A simple tubular contracted alimentary canal, with an elongated stomach, teeth in rows, attached to two jaws, situated at the head or bulb of the œsophagus, and two pancreatic glands, compose the apparatus of nutrition. The visual organs are red when the animalcule

is young, and colourless in old age. The ovarium has only a single ova. The lorica is a viscid, gelatinous, cylindrical box (*urceolus*), into which the animalcule can entirely withdraw itself, or leave, when a new one is desirable. The attachment to the bottom of the lorica is by the under surface of the end of the foot-like tail.

569. Oecistes *crystallinus*. *The crystalline Oecistes.*—Lorica hyaline, viscid, floccose; body crystalline. The structure of this creature is difficult to see. Each jaw has three distinct teeth. The development of the young from the egg is interesting to observe: Dr. Ehrenberg saw within the shell two dark points (eyes) near the already-developed jaws, and on giving the egg a gentle pressure it burst, and the free young animalcule came forth. *Fig.* 361 represents a full-grown animalcule in the act of unfolding itself; *fig.* 362 is another with its rotatory organ expanded. Their shells are incrusted, and within may be seen a number of eggs; *figures* 363, 364, represent them attached to the pectinated leaves of the water violet, as they appear under a shallow pocket magnifier. Length, with tail, 1-36th; without, 1-140th: lorica 1-70th.

Genus CXXXIX. Conochilus. *The lipped-top Animalcules* are social, having conglomerate and contiguous lorica; each animalcule has two permanent eyes. Only one species is known; its description, therefore, will include that of the genus.

570. Conochilus *volvox*. *The rolling Conochilus.*—The corpuscles are white, their gelatinous lorica is hyaline, within which from ten to forty animalcules unite, and form a radiating sphere, that revolves in swimming. The brow,

or frontal region of the animalcule, is broad, truncated, and surrounded with a wreath of cilii, interrupted at the mouth, which is lateral. On the frontal plane arise four thick conical papillæ, often furnished with an articulated bristle, especially the two anterior, as seen in *figures* 365, 366, and 368. The œsophagus is short and narrow, its head, or bulb, has jaws, with teeth, and four muscles; it lies immediately within the mouth. The stomach and rectum are oval (Gasterodela). Two spherical, pancreatic, or salivary glands, are observed near the œsophagus, and posteriorly an ovarium, often containing a large ovum, which is expelled near the base of the tail. The ovate or shortly-cylindrical body terminates in a long, thin, and strong cylindrical foot-like tail, the end having a suction disc. The gelatinous nucleus, or lorica, is only perceptible in coloured water, except when infested with green parasitical Monads; within it the animalcules can completely withdraw themselves, their tails becoming thickened and bent. (In the *group, figures* 365 to 368, the lorica is not shewn.) There are no anterior muscles, but three pair of posterior ones, which disappear near the rotatory organ; there is also a back pair and two lateral pairs. Several transverse vessels appear connected with two anterior, lateral, longitudinal vessels, which, Dr. Ehrenberg states, must arise from a vascular network near the head, as in Hydatina. He has also seen two spiral bands (gills), situated posteriorly. Two beautiful red visual organs lie immediately beneath the wreath of cilii, and behind them little oval nervous ganglia. In the foot-like tail are two large wedge-shaped glands, probably male organs. These creatures

will feed upon carmine and indigo, but are mostly filled with a golden-coloured food. *Fig.* 370 represents a cluster of animalcules magnified about ten diameters, of which *figs.* 365 to 368 represent a portion, highly magnified; the first is an under view, the two next dorsal views, and the last a side view. *Fig.* 369 shews the jaws, teeth, and part of the œsophagus-bulb separate. Size 1-60th; sphere 1-9th.

Family XXV.—MEGALOTROCHAEA

Have no envelope or lorica, but possess a simple rotatory organ, incised or flexuose at the margin; this constitutes the purveying aud locomotive apparatus. Distinct muscular bands are seen, which can change the shape of the body. In Megalotrocha, the alimentary canal is provided with two jaws, a stomach, two cœca, and two pancreatic glands. In the other genera, it is a simple canal, without stomach and cœca; Microcodon has two single-toothed jaws, but no pancreatic glands; and Cyphonantes is toothless. The ovarium in all the genera developes a few large ova. In Megalotrocha, the ovum is attached to a thread; vessels and tremulous gills are observed in that genus; organs of sensation are indicated by the red eyes in two genera; in the other, a ganglion is seen in their place. In Megalotrocha radiating nervous ganglia, similar to a brain, and four dark glandular spheres, in the neighbourhood of the mouth, are seen.

The genera are thus related:—

Eyes absent		Cyphonautes.
Eyes present	one eye	Microcodon.
	two eyes	Megalotrocha.

Genus CXL. Cyphonautes. *The hump-backed Animalcules* are destitute of eyes. Locomotion is performed by the continuous but notched cilii wreath and an internal band-like muscle. The nutritive apparatus consists of a toothless œsophagus, an alimentary canal, with probably a pancreatic gland; an ovarium, with a single large ovum,

is visible; vessels and tremulous gills unknown; a nervous system is indicated by a round glandular knot at the œsophagus.

571. CYPHONAUTES *compressus.* *The three-lobed Cyphonautes* is white, the body compressed, obtusely triangular, truncated anteriorly, and sub-acutely gibbous upon the back; near the œsophagal head is a spherical gland, probably a brain; no eye with coloured pigment is present; on each side a band-like muscle proceeds to the end of the back, which terminates in a changeable wart (perhaps suction disc). It swims with a vacillating motion. *Fig.* 373, *plate* viii., represents a full-grown animalcule. Found in sea water. Size 1-100th.

Genus CXLI. MICROCODON. *The bell little fish Animalcules* possess a single eye, the simple wreath of cilii bent in the middle resembles the figure 8 lying transversely; the alimentary canal is thick and straight, without a stomach; it has no œsophagus tube, but has a sort of œsophagal bulb and a couple of single-toothed jaws; also a turbid ovarium. Immediately behind the rotatory apparatus is a small red visual organ, and at the frontal region beside it is a reddish knot, whose function is unknown.

572. MICROCODON *clavus.* *The bell Microcodon.*—Body campanulate, pedicled, the styliform foot-like tail as long as the body; in the middle of the brow are two bundles of stiff bristles, and two pincer-like points, evidently teeth, project out of the middle of the rotatory organ, and are in connexion with the reddish jaws. *Fig.* 371 is a back, and 372 a left side view. Size 1-280th.

Genus CXLII. MEGALOTROCHA. *The parasol or great wheeled Animalcules* possess two eyes, which sometimes

become effaced by age. The rotatory organ has two lappets; the nutritive system consists of a stomach, cœcum, rectum, an œsophagal head, having two jaws, with teeth, and two pancreatic glands; reproductive organs, a short knotted ovarium, with a few ova; muscles, three pair anterior, two pair posterior longitudinal, two contractile muscles for the rotatory organ, and four œsophagal. The eyes are frontal, of a red colour when young; two many-partite radiant nervous masses are distributed in the disc of the rotatory organ; these represent the nervous structures and organs of sensation, and four circular transverse-lying vessels are also seen. The nature of the four opaque white spherical bodies at the base of the rotatory organ is unknown.

573. MEGALOTROCHA *albo-flavicans* (*Vorticella socialis*, M.) *The yellowish-white Megalotrocha* is white and free, when young, yellowish and attached in radiating clusters when old. Ehrenberg states he has often perceived the red eyes in the closed ovum, and the jaws, as if in the act of chewing, move laterally and horizontally against each other. Two ova are rarely produced at one time; the ovum, when expelled from the body, remains attached to it by a thread, and the parent has often four or five thus attached, which are thus further developed. Ehrenberg's observations on the embryo are highly interesting: he says, "In the ovum, whilst within the ovarium, a bright germ makes its appearance as a round bright spot; within this a turbid nucleus developes itself, which at first is surrounded with a bright broad margin of fluidity; within the nucleus a central bright vesicle, like a yolk, is gradually developed; the ovum is then expelled. The embryo is now quickly

developed within the vesicle of the nucleus or yolk, and becomes visible when this latter is consumed; a turbid central spot then appears, which becomes the œsophagal bulb and teeth; a blackish granular oval body is also seen posteriorly, the eyes gradually become red, and a motion of the cilii is visible: after some hours the whole fœtus, which is folded up, turns itself round, the shell bursts, and the young animalcule creeps out; it then fixes itself between the older ones, but in a little time the young creature detaches itself and swims about as a rolling sphere, but, at the expiration of a certain period, attaches itself to some firm body." *Figures* 374 to 376 represent different specimens; *figure* 377 is merely the teeth and jaws separate. Found upon water plants. Size of single animalcule 1-36th; of the spheres 1-6th.

Family XXVI.—FLOSCULARIA

Comprehends Rotatorial Animalcules enveloped in a case, and provided with a single rotatory organ, flexuose at the margin, and lobed or divided with from two to six clefts; when the latter number, it appears compound. The cilii of this organ in some genera are quiescent, and only vibratile occasionally. The alimentary canal has toothed jaws, and generally a stomach; the genus Lacinularia only has cœcal appendages to the latter, but in all of them oval or semi-spherical pancreatic glands are seen. The reproductive organs are, a short ovarium, in which only a few ova are developed at a time, and in Lacinularia, Melicerta, and perhaps in Floscularia and Stephanoceros, male glands; in Lacinularia four transverse circular vessels, and a strong vascular network at the base of the rotatory organ, are seen; internal tremulous gill-like organs in Lacinularia and Stephanoceros only; eyes are distinct in all, except Tubicolaria. In Lacinularia, Limnias, and Melicerta, brain and masses of nervous matter are seen. Touching their muscular structure, two pair of muscles seemingly contract the body posteriorly; the rotatory organs of Lacinularia and Melicerta have especial ones. The evolution of young in the ovum takes place as in Hydatina.

The family is disposed in genera, thus:—

Eyes absent			Tubicolaria.
One eye present (when young)			Stephanoceros.
Two eyes present (when young)	rotatory organ two-parted when full-grown	envelope of the single animalcules distinct or separated	Limnias.
		envelope of the single animalcules conglomerated	Lacinularia.
	rotatory organ four-parted when full-grown		Melicerta.
	rotatory organ five to six-parted when full-grown		Floscularia.

Genus CXLIII. Tubicolaria. *The encased wheel Animalcules* are destitute of eyes at all ages (?) have a four-lobed rotatory organ, and a gelatinous case (*urceolus*). Their internal structure comprises four posterior longitudinal muscles, an alimentary canal, with a long stomach, devoid of cœcal appendages; a short rectum, an œsophagal head with four muscles, two jaws with teeth, two semi-spherical pancreatic glands, and an ovarium, with a single ovum. Anteriorly, upon the ventral surface, are two respiratory tubes.

574. Tubicolaria *najas*. *The mantle Tubicolaria.*—The jaws have four teeth, and the respiratory tubes are hairy anteriorly. It is described fully in the account of the genus, and *figures* 379 to 382 will illustrate it; 381 represents those of the natural size, as found attached to the roots of Lemna polyrrhiza, with those of the following genus; 379 represents an animalcule within its case, the rotatory organ withdrawn; 380, another animalcule extended, and without its lorica. *Fig.* 382 shews the œsophagus, with the jaws and teeth separate. Length 1-36th.

Genus CXLIV. Stephanoceros. *The crown-wheel Animalcules* have one eye, and a rotatory organ, deeply divided into lobes, and furnished with verticellate cilii: this organ performs the office of locomotion. Their nutritive apparatus consists of a simple alimentary canal, with a stomach, and small rectum; the œsophagal head has jaws, with free teeth, four in number; before it is a large crop-like structure, and two glands at the stomach; the ovarium only developes a few ova at a time; perhaps two male glands exist at the commencement of the row of tremulous gills; a red visual point, with a row of nervous

ganglia, in pairs, are visible at the base of the rotatory organ; young animalcules possess a small glandular dark body internally.

575. Stephanoceros *Eickhornii.* *Eickhorn's Stephanoceros.*—The case of this creature is transparent, like glass; its rotatory organ has five lobes or arms, each furnished with fifteen verticellate cilii; these arms it employs as a prehensile instrument occasionally, and spreads them out, as shewn in the engraving, *fig.* 383, which represents a full-grown animalcule, with four ova within it; two have the young developed, which are only expelled when in this state: hence, Dr. Ehrenberg considers this creature viviparous. In this figure the eye and gills are visible, and over the latter the ganglia. The case is difficult to be discerned under the microscope, from its very transparent nature, unless indigo is mixed with the water. Length 1-36th.

Genus CXLV. Limnias.—These animalcules have two eyes, a solitary little case (*urceolus*), and a rotatory organ, two-lobed when full-grown, being then constricted in the middle; the apparatus of nutrition consists of a simple alimentary canal, terminating at the base of the tail, a stomach, two jaws with teeth, and two pancreatic glands; the ova are deposited within the case, and then developed; neither male organs, gills, or vessels, have been discovered; two visual organs indicate a system of sensation; these, in the young animalcules, are red, and are even visible within the ovum, but in old age the colour disappears, and hence they are not seen; in the middle of the rotatory organ, when expanded, are seen four large balls, which Dr. Ehrenberg considers nervous ganglia, or brain.

576. LIMNIAS *ceratophilli.* *The hornwort Limnias.*—Case white at first, afterwards brown, or blackish; it is smooth, but, being viscid, is often covered with extraneous particles, its connexion with the animalcule is a voluntary act of the latter; the two red eyes and the jaws may be observed in the ova, when developed, and by giving them a gentle pressure the shell bursts. *Fig.* 389 exhibits an animalcule just emerged from the egg, 392. *Fig.* 391 is a young specimen, with the rotatory organ nearly circular; it also shews the two eyes. *Fig.* 390 is a full-grown specimen, without its case, fed on indigo, the jaws (each of which has three strong teeth), the ova, and traces of two (four?) longitudinal muscles, are seen: the wheel is folded up. *Fig.* 388 is another within its case, having the lobed rotatory organ expanded. Found upon hornwort (Ceratophyllum), and other aquatic plants. Length about 1-20th; case 1-40th.

Genus CXLVI. LACINULARIA. *The horse-shoe Animalcules* have two eyes (in the young state), the cases (*urceoli*) conglomerate, or grown together, and the rotatory organ two-lobed, when full grown, but circular when young; this organ is the chief instrument of locomotion: band-like longitudinal muscles run within the body. The nutritive apparatus consists of a large œsophagal head, having two jaws, with teeth in rows, a short narrow œsophagus, an elongated stomach, but with no cœca-like appendages; two ovate pancreatic glands, and a short globose rectum. The ovarium is situate about the middle of the body, and contains but a few large ova; four fecundating glands appear below the discharging orifice, which latter is common to the ovarium, and alimentary canal;

transverse circular canals, vascular network at the base of the rotatory organs, and tremulous gill-like bodies, are observable. The system of sensation is indicated by the visual organs, which rest on ganglia; they are red in the developed ovum and young animalcule, but become blackish or disappear with age. Near the œsophagus is situated a nervous mass (analogous to brain), divided into four to six lobes, also (as in Megalotrocha) two ring-like radiant processes with a row of ganglia, these lie beneath the muscles of the cilii wreath; the longest lobes (ganglia) are seen from the ventral surface.

577. Lacinularia *socialis* (*Vorticella socialis et flosculosa*, M.) *The social Lacinularia.*—Lorica gelatinous, of a yellowish colour, and conglomerate, several (from ten to sixty) uniting to form a spherical mass. Each animalcule is fixed by its tail to a separate cell, within which it can entirely withdraw itself. It has a large horseshoe-shaped rotatory organ; seven or eight eggs are deposited, free, within each cell; the young, when hatched, form a new cluster, swim away, and form loricæ; when only one is born, it attaches itself at the side of the parent. *Fig.* 378 is an animalcule separated from the mass; it is highly magnified, and exhibits the organization described under its genus. Found on chara and other aquatic plants. Length 1-36th.

Genus CXLVII. Melicerta. *The four-leaved Animalcules* have two eyes (at least when young), solitary cases, and a single rotatory organ, with four lobes, when expanded. It has free longitudinal muscles for the contraction of the body; the alimentary canal is broad and simple, with a stomach-like division; its œsophageal head

has four muscles, two jaws, with teeth in rows, and two pancreatic glands; the mouth is situated under the large leaves or lobes of the rotatory organ; the discharging orifice is at the base of the prehensile tail: the propagative system resembles the preceding genus, but the male portion is not satisfactorily known. A vascular system has not been observed, but the two tubular processes beneath the mouth are probably subservient to respiration; the two frontal eyes in the ova and young animalcules, together with the curved glandular band of nervous matter in each leaflet of the vibratile organ, represent the system of sensation; the chewing movement of the mouth has been often mistaken for the action of a heart.

578. MELICERTA *ringens. The ring-tailed Melicerta* has a conical granulated case, resembling a honey-comb, of a brownish-red colour; it is composed of small lenticular bodies, expressly deposited by the animalcule from the posterior alimentary opening (and not foreign matter, like the habitations of the larvæ of the Phryganea); these are agglutinized by a peculiar viscid matter, also exuded, and afterwards hardened in the water. Into this tube the soft crystalline or whitish animalcule can withdraw itself; when its flower-like wheelwork is expanded, the vibratile cilii appear to run along the margin of this organ, but, in fact, each single cilia only turns itself upon its base, and the aggregate motion causes a little whirlpool in the water, directed towards the mouth, situated in the middle of the two large leaflets of this organ; the eyes are placed near the two other bent leaflets, which, according to Dr. Ehrenberg, are analagous to a cleft upper lip of the dorsal surface; the discharging orifice is on the same side, and

therefore the dorsal tail-like portion becomes a ventral member, or foot. *Fig.* 386 exhibits an animalcule within its case, and having the rotatory organ contracted: *fig.* 387 is another, with the latter fully expanded; in this drawing, an outline only of the case is given, in order to shew the internal structure. Two of the ova exhibit the eyes and teeth, the latter are formed first. Found upon lemna and other aquatic plants. Length 1-12th; case 1-24th; egg 1-150th.

Genus CXLVIII. Floscularia. *The flower wheel Animalcules* possess (when young at least) two eyes, and a rotatory organ, four or five (?) or more lobed. These elegant animalcules have each a distinct gelatinous case, the ends of which are attached to water plants. They are often so very diaphanous as to escape observation, unless the water is rendered turbid with colour; the rotatory organ is so very peculiar in structure that some observers do not consider it as such. The alimentary canal is simple and conical (Coelogastrica), but is remarkable as possessing a second œsophagal bulb or head, the lower one only having jaws and teeth; two pancreatic glands are present anteriorly. The propagative system resembles Lacinularia. The ova are deposited in the case; vessels unknown. The red eyes indicate sensation. They resemble in appearance somewhat Acineta.

579. Floscularia *proboscidea.* *The proboscis Floscularia* is large, has a cylindrical hyaline gelatinous case, and a six-lobed rotatory organ, with short cilii, surrounding a ciliated flexible proboscis, which has apparently an opening at its end. The body is ovate, and has a long styliform contractile foot-like tail attached to the base of its case; when extended,

the body and part of this foot are protruded. Found upon the leaves of Hottonia palustris. Length, when extended, 1-18th; case 1-36th.

580. Floscularia *ornata* (*Cercaria*, M.) *The adorned Floscularia* is small, case hyaline, rotatory organ six-lobed, no proboscis. This animalcule is sluggish and unfolds itself slowly, but often contracts quickly within its case. The end of each lobe of the rotatory organ is thickened, and has from five to eight very long cilii, generally stretched stiffly out. They are very fond of Chlamidomonas, and when they swallow large bodies, as Naviculæ, contract the whole body. Ehrenberg has numbered as many as five ova in the case at one time: some were generally quite developed, shewing the movement of the young, with the two red eyes. Under a slight pressure the shell burst, and the young animalcule crawled out, slightly vibrating. The cilii were short and not very distinct, but the œsophagal head was in action. When old, the foot-tail is truncated, and during contraction has transverse folds; rotatory organ extended, with five lobes. Found upon Ceratophyllum. Size of body 1-108th.

Family XXVII.—Hydatinaea.

The members of this highly-organized and extensive family of rotatory animalcules are destitute of lorica; they possess a wheel-like apparatus, or vibratile organ, divided into several distinct series or parts, always more than two in number. The compound state of this organ is best expressed by saying that it is not a mere circular or semicircular row of cilii, but several rows or groups, completely separate from each other. They are situated on the anterior part of these soft-bodied animalcules. All the genera, Polyarthra excepted, have a tail-like foot, or a styliform or pincer-formed process, on the abdomen—hence not properly a tail, that member being always a prolongation of the dorsal surface. In several of the genera, the muscles for altering the form of the body are distinct. The nutritive system is completely elicited in all; it consists mostly of a simple conical tube for the alimentary canal, without a stomach-like division (Coelogastrica); but Diglena catellina, Polyarthra, and Triarthra longiseta, have true constricted stomachs. Enteroplea, Notommata myrmeleo, syrinx, clavulata, the Synchaetae, and Diglena lacustris, have a long œsophagus or stomach, and a suddenly-attenuated discharging canal (Gasterodela). Enteroplea alone has radiant vessels at the œsophagus. Notommata clavulata and Diglena lacustris have special cœca at the stomach. Enteroplea is the only genus destitute of teeth, though doubtful in Rattulus. Pancreatic glands, under different modifications, are present in all the

genera. The propagative system is distinctly hermaphroditic in fifteen genera. The ovarium, which only evolves a few large ova at a time, is mostly ovate: in Notommata myrmeleo, clavulata, and in Diglena lacustris, it is very long. It communicates, by a short oviduct, with the alimentary canal near its termination. None of the species are viviparous. The male organs, when present, consist of two filiform, extended, wedge-shaped glands, and a contractile vesicle. The egg is worthy of notice, having sometimes a smooth soft shell, at others a hard spinous one; the latter is termed the winter ovum, and considered by M. Turpin as constituting the genera Bursella and Erithrinella (?) of plants. In eleven genera, a vascular system, composed of transverse and longitudinal vessels, a cervical net-work and free tremulous organs, like gills, with respiratory tubes or openings in the neck, is observed. The system of sensation is indicated by the presence of eyes, mostly red, with a ganglion beneath them; these organs being anterior upon the edge of the upper surface of the body, or in the neck opposite to the mouth, indicate the back or dorsal surface of the animalcule; also nerve-like fibrillæ exist in several species of Notommata, Diglena, Enteroplea, Triarthra, and especially in Hydatina. Some species of Synchaeta evolve light and give rise to the phosphorescence of the sea. Hydatina senta, Diglena catellina, and Triarthra, are sometimes so numerous as to render the pools of water in which they reside milky and turbid.

The genera are related as follow:—

- Eyes absent
  - teeth absent .... **Enteroplea.**
  - teeth present
    - jaw many-toothed .... **Hydatina.**
    - jaw single-toothed .... **Pleurotrocha.**
- Eyes present
  - one
    - frontal .... **Furcularia.**
    - cervical
      - foot styliform .... **Monocerca.**
      - foot furcated
        - frontal cilii, no uncini or styles **Notommata.**
        - frontal cilii and styles .... **Synchaeta.**
        - frontal cilii and uncini .... **Scaridium.**
      - no foot, but a many partile beard, or fins **Polyarthra.**
  - two
    - frontal
      - foot furcated .... **Diglena.**
      - foot styliform
        - beard .... **Triarthra.**
        - no beard .... **Rattulus.**
    - cervical; foot furcated .... **Distemma.**
  - three
    - non-pedicelled
      - cervical .... **Triophthalmus.**
      - two frontal, one cervical .... **Eosphora.**
    - two pedicelled frontal eyes, one non-pedicelled cervical eye .... **Otoglena.**
  - with many simply conglomerate eyes, more than three .... **Cycloglena.**
  - with many doubly-conglomerate eyes, more than three .... **Theorus.**

Genus CXLIX. Enteroplea. These rotatory animalcules have neither eyes nor teeth, but possess a fork-like foot; the cilii of the vibratile organ are disposed in bundles, based in semi-globular muscles. Several longitudinal muscles move the body, others the foot-like pincers. The nutritive organs are a long œsophagus, with a bulb or head, surrounded by a radiant (vascular?) wreath. The alimentary canal is conical; it has, anteriorly, two ear-like pancreatic glands, is suddenly diminished posteriorly, and terminates where the muscles of the foot commence. The propagative structures are an extended ovarium, two thin wedge-shaped

glands, and a contractile vesicle. The vascular system is indicated by many parallel transverse circular canals, and a large tremulous organ, similar to a gill, near the contractile vesicle. A brain-like knot, situated near the œsophagus, sends off a thick tortuous thread along the dorsal surface to the second transverse vessel, where the respiratory opening probably exists. Posteriorly, near the alimentary canal, is a dark granular organ, whose function is unknown.

581. ENTEROPLEA *hydatina*. *The crystalline Enteroplea.* —Body conical, transparent, with a little forked foot. Anteriorly, four longitudinal muscles reach to the middle of the body, and one dorsal, one ventral, and two opposed lateral ones, are also seen. Two internal short wedge-shaped muscles move the pincer-like foot. Ehrenberg counted ten or eleven circular canals in the vascular system. This animalcule is always smaller than Hydatina senta, which it greatly resembles. *Fig.* 393 represents this animalcule, in which the internal parts, named in the generic description, are shewn. Length 1-120th.

Genus CL. HYDATINA. *The crystal Animalcules* are destitute of eyes, but have two many-toothed jaws (*fig.* 383*) and a fork-like foot; locomotion is effected by the compound wheel organ, the pincer-like foot, and internal muscles; the latter are most numerous in H. senta. The alimentary canal has a globose œsophagal head, with four muscles and jaws, and with two to five teeth. In H. senta the jaws are connected by a short œsophagus to a simple conical alimentary canal; in the other species, to a constricted one; the large anterior extremity has two spherical glands. The ovarium is globular. Two thin wedge-shaped

glands open into a contractile vesicle for fructification. The vascular system and gills are observed in H. senta. In both species the central ganglia, with its cervical thread or loop, is visible.

582. HYDATINA *senta* (*Vorticella senta*, M.) *The large Hydatina.*—Body conical, hyaline; margin of the rotatory organ ciliated; foot truncated and robust. The vibratile organ, when extended, is always in motion; it consists of a simple external wreath of cilii, somewhat interrupted at the mouth, and eleven internal bundles of cilii, each enveloped in a muscular sheath. The body has nine muscular bands thus situated; one upper or anterior dorsal muscle (no under or posterior one), two anterior ventral, and two posterior ones closing thereon; one right, and one left anterior lateral, with posterior ones in continuation. The five anterior muscles arise between the muscular bundles of the rotatory organ, mostly at the margin; the dorsal ones arise from the centre, near the central ganglion, and are collectively attached to the internal skin of the abdomen, between the fourth and fifth transverse vessels, their inserted extremities being enlarged. Here the four posterior muscles arise, and are inserted where the pincer-like foot projects; two longitudinally-striated muscular sheaths encase the inner root of the divided foot; and there is a sphincter to the anal opening. The fibrous structure of the band-like longitudinal muscles, as sometimes also transverse corrugations of the fibres, are as distinct as in the larger animals. During the contraction of the body, they become shorter and broader, by which they are easily distinguished from the other band-like and filiform organs, which only become curved during contraction of the body

(maintaining themselves passive). The alimentary canal has no true stomach, the posterior diminishes, and the internal surface is provided with delicate vibratile cilii; it sometimes appears grape-like, from having semi-lunar valves, which form little lateral pockets or stomachs: the ova often occupy a large portion of the body. In most cases, the creature fixes itself to a spot by its foot, and lays several eggs upon the same place, one after another, by a sudden contraction; sometimes, when it is going to lay more eggs, it returns to the original spot. In eleven hours after the eggs were laid vibration of the anterior cilii was observed, by Ehrenberg, within them; and in twenty-four hours the young escaped from the shell. Many of the ova have a double shell, and leave a bright space between each at one of the extremities, and such ova are found in other rotatory animalcules, having different shapes. In these, the young are slowly developed. Ehrenberg names them, "lasting eggs, or winter eggs." Some eggs are covered with Hygrocrocis, and appear quite hairy; these have been regarded as the normal state of other ciliated animalcules. Two kinds of diseases destroy the Hydatina, and most of the Rotatoria: 1st, the formation of vesicles, or little bladders, which give rise to the appearance of small rings all over the creature: 2nd, the formation of granules, from which all the internal organs appear as if composed of delicate granules and shagreened; a third disease may be the overgrowth of algæ upon their bodies. Foul water likewise kills them. *Fig.* 394 represents a vibrating animalcule completely unfolded, seen from the ventral surface. The arrows in the alimentary canal indicate a decussating, or circulating movement of its contents,

produced by delicate internal cilii, and must not be mistaken for the motion of Monads.

583. HYDATINA *brachydactyla. The little Hydatina.*—Body cylindrical, truncated anteriorly, and suddenly attenuated at the base of the foot; claws short. Found on Hottonia, &c. Length 1-144th.

Genus CLI. PLEUROTROCHA. *The awl-shaped tooth Rotatoria* have no eyes, but possess a single tooth in each jaw, and a furcated foot. The rotatory organ consists, not of a simple wreath of cilii, but of cilii distributed in bundles near each other, the bundles being placed in muscular cases. In P. gibba there are two muscles for moving the foot, and in all the species the œsophagal head has four. This head is globular, it has two single-toothed jaws (*fig.* 396); these, and the short œsophagus, the simple conical alimentary canal, having anteriorly two spherical pancreatic glands, constitute the nutritive apparatus. The posterior opening of the canal is at the base of the foot, upon the dorsal surface. The propagative system consists of a globular ovarium. In P. leptura a contractile vesicle is seen. Organs of sensation are not satisfactorily known, and the nervous loop in the neck of the Hydatina appears wanting in this genus.

584. PLEUROTROCHA *gibba. The thickened Pleurotrocha.*—Body truncated anteriorly, enlarging from the front towards the base of the foot, where it is suddenly attenuated, the toes, or claws, short and turgid; near the mouth is a beak-like projection, forming an under lip. *Fig.* 395 is a right side view, and *fig.* 396 the teeth and œsophagal head dissected out. Found with Hydatina brachydactyla. Length 1-216th.

585. Pleurotrocha *constricta. The robber Pleurotrocha.*—Body elongated, conical, and separated from the head by a stricture; front oblique, toes straight and slender. This animalcule is very active and powerful; it seems to be predaceous. Found upon Ceratophyllum. Length 1-144th.

586. Pleurotrocha *leptura. The thin-footed Pleurotrocha.*—Body turgid in the centre, front oblique, foot slender, toes thin and slightly curved. Found amongst conferva. Length 1-144th.

Genus CLII. Furcularia. *The forked-fish Rotatoria* have a single frontal eye, and a forked foot resembling a tail; the vibratile organ is compound. Longitudinal muscles exist in F. gibba, and foot muscles in three species. The œsophagus is very short, its head has two jaws, each with a single tooth (*monogomphia*), in two species, but not in the others; a simple conical alimentary canal (*coelogastrica*), with two ear-like glands, exists in all the species, and ovarium is distinct; but in F. gibba only a contractile vesicle. Vessels, respiratory tubes, gills, &c., are not recognizable; the organs of sensation are a red visual point on the frontal region, and in F. Reinhardti a sort of brain-like mass is seen.

587. Furcularia *gibba. The hump-backed Furcularia.*—Body oblong, slightly compressed, under side flat, back convex, toes forked, long (styliform), equal to half the body; the eye is placed upon a nervous ganglion over the mouth, clearly indicating the dorsal surface; the ovarium has, generally, one large and ripe ovum; the movement of this animalcule is somewhat slow. Found in green water, and amongst conferva. Length 1-96th.

588. Furcularia *Reinhardti*. *Reinhardt's Furcularia.*—Body fusiform, truncated in front, foot elongated, cylindrical, and shortly furcated at the end; a slight stricture divides the body and head. *Plate* ix., *fig*. 397, represents this animalcule extended, and *fig*. 398, another, contracted; the former is a side (right), the latter a back, view. Found as a parasite upon Monopyxis (Sertularia) geniculata, in sea water. Length 1-120th.

589. Furcularia *forficula*. *The ear-wig Furcularia.*—Body cylindrical, obtusely pointed in front, the toes very long, rounded, and dentated at the base, on the upper side; the rotatory organ appears to have two frontal clusters of cilii near the eye, and a wheel-like bundle on each side. Length 1-144th.

590. Furcularia *gracilis*. *The slender Furcularia.*—Body slender, cylindrical, suddenly attenuated at the base of the furcated foot; toes straight, long, and shorter than half the body. The rotatory organ appears disposed in six muscular cases, between, and superior to which, is a longish central ganglion, with a red eye. Found in green water. Length 1-180th.

Genus CLIII. Monocerca. *The filiform-tailed Rotatoria* have a single eye, situate in the neck, and a simple styliform foot, resembling a tail. In two species the vibratile cilii are distributed into about six bundles, their band-like longitudinal muscles, and those of the foot, producing locomotion; the sides of the œsophagal head are unequal, as also the two jaws, which have one or two teeth; the œsophagal tube is curved and long, and the simple alimentary canal is conical, with two ear-like pancreatic glands anteriorly. An ovarium and contractile vesicles evidence

hermaphroditism. In two species a projecting respiratory tube at the frontal region indicates the existence of the vascular system; the red eye, upon a nervous ganglion, indicates the presence of a system of sensation in all the species.

591. MONOCERCA *rattus* (*Trichoda rattus*, M.) *The rat Monocerca.*—Body ovate, oblong, truncated anteriorly, and unarmed; foot styliform, the length of the body. This creature swims slowly, in a stiff manner; when stationary, it throws the styliform foot backwards and forwards. The ovarium has a reddish colour; behind it lies a roundish contractile vesicle. The foot has a short base, with a cordate internal muscle, and four unequal bristles. Found amongst conferva, &c. Length 1-120th.

592. MONOCERCA *bicornis. The two-horned Monocerca.*—Body ovate, oblong, truncated in front, armed with two spines; foot styliform, a little shorter than the body; the oblique œsophagal head exhibits delicate transverse corrugations; it has a bent and straight jaw, with probably three teeth in each. *Fig.* 399 represents an animalcule (right side); *fig.* 417 another, contracted, and having its rat-like tail bent. Length 1-72nd.

593. MONOCERCA (?) *valga* (*Vorticella valga*, M.) *The little Monocerca.*—Body small, almost cubical, with distinct head, an elevation on the back, and a conical foot, unequally forked; the rotatory organ, during contraction, shews four muscular sheaths, and the distinct red eye is placed upon a less distinct ganglion; the œsophagal head is not evident. Length 1-288th.

Genus CLIV. NOTOMMATA. *The neck-eyed Rotatoria* have a single eye upon the neck, a bisulcated foot, resem-

bling a forked tail, and a rotatory organ, simply ciliated, and disposed in bundles on the frontal region; eight of the larger species have numerous muscles; eighteen or nineteen have two jaws, each furnished with a single tooth; in eight the jaws have many teeth; the œsophagus is mostly short, with a simple wide conical alimentary canal (*coelogastrica*); in N. tuba only is there a stomach-like division, with a constriction (*gasterodela, α*), and in N. myrmeleo, syrinx, and clavulata, there is also a stomach-like enlarged place, but no constriction (*gasterodela, β*); cœcal appendages are observed only in N. clavulata. The two earlike anterior appendages of the alimentary canal, regarded as pancreatic glands, exist in twenty-four species. The propagative system evidently is hermaphroditic in sixteen species; in the others the ovarium only is seen; none are viviparous: N. syrinx alone was observed by Ehrenberg to contain fully developed ova. The vascular system is represented, in ten species, by delicate tubes, with flexible and tremulous gills; only three of the smaller species have gills: in N. myrmeleo and syrinx, a broad vascular network is distinct about the head: a prominent respiratory (?) tube in the neck is present in four or five species; in some others an opening alone is seen. The visual point is red, except in N. felis, where it is colourless; a ganglion is placed beneath the eye in twenty-six species. In N. copeus and centrura, the brain is three-lobed, and placed upon the head of the œsophagus; in the rest it consists of one or more nervous ganglia, situated amongst the vibratile cilii-muscles of the frontal region; free nervous threads and ganglia are also observed in different members. This genus is especially remarkable for the parasitical habits of

the animalcules. They live upon other Rotatoria, upon the polygastric infusoria, and even in the globular masses of Volvox globator; but, says Ehrenberg, "not like a cuckoo's egg in a hedge-sparrow's nest, but like the bear and the bee-hive, or a bird's nest in a wasp's nest."

(*a*). *Sub-genus* LABIDODON.—*One tooth in each jaw.*

594. NOTOMMATA *myrmeleo.* *The bell Notommata.*—Body large, bell-shaped; foot short, lateral; teeth curved in a circular forceps-like manner. (See *fig.* 420.) There are two varieties: in the one (var. α) a long thin œsophagus, a globular thick stomach, and a long empty rectum, compose the alimentary organs. Ehrenberg, by pressure, made an animalcule, whose dark stomach nearly filled the body, disgorge two large specimens of Lynceus minutus (described and figured in the *Microscopic Cabinet*); the animalcule afterwards vibrated away in a lively manner. No respiratory tubes exist, but five transverse vessels and four longitudinal ones (a pair uniting to each of the first two transverse ones,) represent a vascular system in this variety. In the other (var. β) a distinct vascular network is seen at the head, but only four transverse vessels, and two longitudinal ones, going to the first. The red eye is much larger in this variety. *Fig.* 418 represents a side view of the variety β, in which the various parts of its organization, as heretofore described, is clearly seen, as also a small crustacean, within its stomach. *Fig.* 420 shews the structure of the manducatory organs separated. *Fig.* 419 is the upper part of an animalcule (var. α), shewing the smaller eye, rotatory organs, teeth, and network. Found in clear water, in turf hollows. Length 1-40th.

595. NOTOMMATA *syrinx.*—Body large, bell-shaped; lateral foot scarcely visible, teeth curved and bifid at the points. This species is very similar to the former, and only distinguished from it by its small foot and the spaces within the cilii cluster (mouth) being convex, not concave. Found in a turf pool. Length 1-40th.

596. NOTOMMATA *hyptopus. The belly-footed Notommata.*—Body bell-shaped, nearly globular, rather large; foot slightly prominent at the middle of the belly, teeth small; vibratile organ composed of four or five muscular bundles; œsophagus very short. Length 1-72nd.

597. NOTOMMATA *parasita. The parasitic Notommata.*—Body small, oval; foot short, and teeth small; three or four bundles compose the rotatory apparatus; œsophagal head globose, tube short; alimentary canal stout, simple, usually filled with green matter. This curious animalcule lives in the globular clusters of Volvox globator, where it deposits its eggs, which are therein hatched. When of proper age, the creatures eat their way out through the hollow sphere. Length 1-40th.

598. NOTOMMATA *granularis. The cuckoo Notommata.*—Body short, cylindrical, truncated at both ends; foot slender. The body has always a few dark granular bodies within it. Dr. E. discovered it in 1831. In 1835 he observed eggs of two sizes on the dorsal surface of N. brachionus; the smaller ones were distinguished by dark granules within them, and produced N. granularis. From other observations he concludes these eggs of N. granularis are deposited by the parent upon N. brachionus, like the cuckoo, who lays her eggs in the nests of other birds. Length 1-280th.

599. NOTOMMATA *petromyzon. The lamprey Notommata.*—Body elongated, attenuated at both ends; mouth and rotatory organ lateral. Ehrenberg says, in May, 1835, he found one in a Volvox globator, whose gemmiferous masses it eats like N. parasitica. The eggs are often deposited on Epistylis. Length 1-180th to 1-144th.

600. NOTOMMATA *lacinulata* (*Vorticella auriculata et arcinulata,* M.) *The double-pointed Notommata.*—Body small, conical, truncated, and slightly lobed in front; teeth extended, often bicuspidate. This species is very active. Found with Chlamidomonas pulvisculus in clear water; also in water-tubs. Length 1-280th.

601. NOTOMMATA *forcipata. The scissor Notommata.*—Body small, elongated; toes long, and often crossed; eye very large. The vibratile organ appears sometimes of a simple wreath. Found amongst lemna. Length 1-180th.

602. NOTOMMATA *collaris. The thick-necked Notommata.*—Body elongated, large, gradually attenuated at both ends; neck turgid; toes short. It swims slowly, the vibratile organ being small in comparison with the body. Length 1-48th.

603. NOTOMMATA *Werneckii. Werneck's Notommata.*—Body elongated, gradually attenuated at both ends; toes short. It has two setæ near the mouth. This animalcule resembles N. collaris, but is smaller, and lives in the club-like excrescences of Vaucheria as an entophytic animal. Length 1-90th.

604. NOTOMMATA *najas.*—Body conical, cylindrical, stout, truncated in front; no auricles. It resembles Hydatina senta and Eosphora najas; it is distinguished from

the first by its cervical eye, from the latter by want of frontal eyes. Found amongst lemna. Length 1-120th.

605. NOTOMMATA *aurita* (*Vorticella aurita*, M.) *The double-eared Notommata.*—Back swollen near the tail, and thus gibbous; the corners at the front project like ears. Beneath the eye is an obscure white globular purse-shaped organ. Found amongst conferva, &c.; also beneath ice. Length 1-200th.

606. NOTOMMATA *gibba*. *The arched Notommata.*—Back swollen, front truncated, not auricled, no cerebral sacculi below the eye; toes short; the vibratile organs compound. Found in old exposed infusions. Length 1-200th.

607. NOTOMMATA *ansata* (*Vorticella aurita*, M.) *The handle Notommata.*—Body turgid in the middle, suddenly truncated at both ends; the front auricled, no cerebral sacculi below the eye; toes thick. Found in bog water amongst conferva. Length 1-120th.

608. NOTOMMATA *decipiens*. *The slender Notommata.*—Body cylindrical, not auricled; toes short; the ovarium often contains four large eggs. Length 1-180th.

609. NOTOMMATA (?) *felis*. *The cat Notommata.*—Body small, slender; one horn in front; eye colourless; back attenuated posteriorly, and forked. Length 1-240th.

610. NOTOMMATA (?) *tigris*, (*Trichoda tigris*, M.) *The tiger Notommata.*—Body cylindrical, curved, foot half the length of body, toes very long, and curved downwards; it has a little horn in front; the eye is large and red. Found amongst oscillatoria. Length 1-72nd.

611. NOTOMMATA *longiseta* (*Vorticella longiseta*, M.) *The long-forked Notommata.*—Body cylindrical, truncated

anteriorly; toes styliform, unequal, and two to four times longer than the body; it is active, and frequently leaps, being assisted by its long claws, which resemble tails. *Fig.* 421 is a full-grown specimen. Entire length 1-60th.

612. NOTOMMATA *aequalis* (*Vorticella longiseta,* M.) *The stilt-tailed Notommata.*—Body cylindrical, obtuse in front; toes styliform, equal the length of the body. Length 1-120th.

(*b*). *Sub-genus* CLENODON.—*Jaws many-toothed.*

613. NOTOMMATA *clavulata. The club-bearing Notommata.*—Body bell-shaped, foot conical, very short; pancreatic glands of a club-shape. This creature presents great facility for observing its internal structure, but the limits to which I am restricted preclude my entering into its interesting details. Length 1-96th.

614. NOTOMMATA *tuba. The trumpet Notommata.*—Body conical, trumpet-shaped, dilated anteriorly; foot furcated and acute. It resembles, in form, Stentor Mülleri, but is more active. Length 1-120th.

615. NOTOMMATA *brachionus. The stipitiform Notommata.*—Body dilated, nearly square, depressed, foot slender; eggs pendulous. This creature appears to have a shell, but Dr. E. says it has not: N. granularis, as before remarked, lays its eggs upon it. Length 1-96th.

616. NOTOMMATA *tripus. The three-footed Notommata.*—Body oval, sub-truncated, and slightly auricled in front; it has a short styliform true tail, and forked foot. Length 1-200th.

617. NOTOMMATA *saccigera. The purse Notommata.*—

Body elongated, cylindrical, attenuated posteriorly; fork short. It has a curious internal pouch beneath the eye; vibratile organ lateral, as in Pleurotrocha. Length 1-144th.

618. NOTOMMATA *copeus*. *The telegraph Notommata.*—Body large, attenuated at both ends; tail small, and indurated. This curious creature has a long bristle on each side of its body, and on each side of the head a stout branch, called, by Dr. Ehrenberg, an auricle; these have vibratile cilii around their ends, and, like the setæ, stand out, so that it appears like a cross: a thick gelatinous substance covers the body; the back terminates in a somewhat hard point, which is a true tail, between which, and the foot, the discharging opening is situated. When creeping, the large vibratile arms are withdrawn, but it vibrates with the frontal cilii and proboscis. *Fig.* 416 represents the creature extended. Length 1-36th.

619. NOTOMMATA *centrura*. *The spined-tailed Notommata.*—Body large, attenuated at both ends; tail small, indurated; auricles small, and no lateral setæ present; this is often enveloped in a thick slime, in which articulated threads of Hygrocrocis vegetate, giving the animalcule a hairy appearance. It swims awkwardly. Length 1-36th.

620. NOTOMMATA *brachyota*. *The short-eared Notommata.*—Body small, slightly attenuated towards the ends; no tail, auricles very small; it has two dark spots near the eye; foot forked. Length 1-120th.

Genus CLV. SYNCHAETA. *The bristle-headed Rotatoria* have a single cervical eye; rotatory organs compound, the clusters six to ten, and armed with from two to four

styles; the foot furcated. The strong styles, or bristles, are situated between the clusters of cilii, and, probably, act as teeth; the body is very short, and broad anteriorly, tapering to a point posteriorly, so that it resembles a cone. Internal longitudinal muscles exist in all the species; those of the foot are seen in three species: the œsophagal head is large, with single-toothed jaws, and exists in all the species; but in two only is the whole chewing apparatus distinctly seen. The thin œsophagal tube is long in two species, short in the rest; it leads to a simple, wide, conical, alimentary canal, which has two roundish, or, in one species, conical pancreatic glands. The ovarium is rolled up like a ball; male contractile vesicles exist in three, and sexual glands in two species; transverse vessels (four to ten) are visible in two species; and a respiratory tube, probably, in S. pectinata and tremula, a tremulous gill being also present in the former. The principal nervous matter is a knotty mass surrounding the head of the œsophagus, and in the middle of it is a large, roundish, red eye. In S. pectinata three pair of ganglia and strong nerves are also seen.

621. SYNCHAETA *pectinata*. *The comb-bearing Synchaeta.*—Body short, conical, with two styles, and two crest-like horns anteriorly. "Are these horns," asks Ehrenberg, "respiratory tubes, as in Polyarthra, and in Anuraea?" The liveliness and uniform transparency of this animalcule render it difficult to distinguish its various organs. The styles arise from the muscle of the œsophagal head, and appear as if belonging to simple-toothed jaws. *Fig.* 422 represents a view of this creature (dorsal side); in it the organization, described under the

genus, are seen. Found amongst conferva. Length 1-120th.

622. Synchaeta *Baltica.* *The Baltic Synchaeta.*—Body ovate, rotatory clusters and styles four each; crest single, sessile. This creature is supposed to occasion a luminous phosphorescent appearance in the ocean. In two samples of water received by Dr. Ehrenberg at Berlin, from Kiel, the luminous property existed, but this species, though present, did not evolve any light. Dr. Michaelis, however, has noticed the production of light from this Synchaeta, and Dr. Ehrenberg thinks it only takes place when developing ova. Length 1-100th.

623. Synchaeta *oblonga.*—Body oblong, with six rotatory clusters, and four styles; crest sessile and single. Distinguished from the following by the form of the pancreatic glands. Found amongst conferva, in spring. Length about 1-100th.

624. Synchaeta *tremula* (*Vorticella tremula,* M.) *The tremulous Synchaeta.*—Body truly conical, with six rotatory clusters, four styles; crest none. Length about 1-160th.

Genus CLVI. Scaridium. *The Springer* has a single, flat, lenticular eye at the neck, the compound rotatory organ, armed in front with an uncinus, or hooked bristle, the foot forked, very long, and adapted for leaping or springing—hence the name. An oblique œsophagal head, with unequal double-pointed (single) teeth to the jaws; a short, narrow œsophagus, opening into a simple, wide, conical, alimentary canal, with two spherical pancreatic glands, constitute the nutritive system. Posteriorly, at the intestine, are a ball-like ovarium and a contractile

vesicle; the foot has two club-shaped muscles; a central ganglion exists between the rotatory clusters; the apparent articulations of the foot are very remarkable.

625. Scaridium *longicaudum* (*Trichoda longicauda*, M.)—Foot-tail twice as long as the body, toes half as long as the foot; it springs or leaps quickly, by a rapid movement of the foot; it does not appear to have a lorica, and is remarkable from all other rotatory animalcules by the length and bending in of the foot, which, as also the body, is covered with a stiff skin. Behind the eye is a transverse fold in the neck, where the head draws itself into the body; the foot has also a transverse fold when it bends. *Fig.* 423 represents the animalcule extended (right side); *fig.* 424 is the œsophagal head, with unequal jaws, &c., extended by pressure. Found amongst oscillatoria. Entire length of the body 1-72nd; without the foot, 1-216th.

Genus CLVII. Polyarthra. *The many-finned Rotatoria* have a single cervical eye, no foot, but are provided with cirri, or pectoral fins; the rotatory organ consists of four bundles of cilii, inserted in as many muscular sheaths; they sometimes appear like the double rotatory organ of a Brachionus, and the form of the body resembles Anuraea; but it is, however, soft, and the rotatory organ double: laterally, two longitudinal dorsal muscles are known; the frontal region has little horns, provided with bristles, and upon the breast six strong styles, or beards, forming two clusters, which move in a fin-like manner. The system of nutrition consists of an œsophagal head, having two single-toothed jaws, a short œsophagus, an alimentary canal, with a stomach-like division, produced by a constriction,

and two pancreatic glands. An ovarium exists in both species, and in one of them a contractile vesicle; nothing is known of the vascular system, unless the two soft horns at the brow are respiratory tubes; a large frontal ganglion, and a round red eye, indicate the system of sensation.

626. POLYARTHRA *trigla. The narrow-fingered Polyarthra.*—Body oval, almost square, having six setaceous pinnæ. It swims quickly, and often leaps, like the water flea; this last motion is produced by the fins, or finnæ, the former by the vibratile organs. *Fig.* 425 represents an under side view, while the animalcule is swimming, with the finnæ depressed; *fig.* 400 is a dorsal view, while leaping, or springing; and *fig.* 401 is a side view (right). This creature is infested with Colacium. Found amongst conferva. Length 1-140th.

627. POLYARTHRA *platyptera. The broad-fingered Polyarthra.*—Body oval, almost square, with six serrated broad sword-shaped pinnæ. It is represented at *fig.* 402. Found amongst Chlamidomonas. Length 1-190th.

Genus CLVIII. DIGLENA (?). *The two-eyed Rotatoria* have two frontal eyes, and a forked foot. Excepting the foot, and rotatory organ, they have no external prominent organ, though some protrude the teeth in a pincer-like manner. The nutritive apparatus is indicated by a muscular œsophagal head, having single-toothed jaws; an œsophagal tube, very short, except in D. lacustris; a simple conical alimentary canal in six species; and a constricted one, or stomach, in two species. In all, two pancreatic glands are present, which, in D. lacustris, are long, cylindrical, and two-horned; in the rest they are spherical. The ovarium, in D. lacustris, is band-like; in the others, like

a ball; male contractile vesicles are observed in four species; sexual glands in three. No species is viviparous; none carry their egg hanging to them: transverse vessels are seen in three species, and in one a vascular net-work at the head; tremulous gills are found in three species, in two of which they are evidently attached to the sexual glands. The nervous system is more especially developed in D. lacustris, but indicated in all the species by the coloured eyes.

628. DIGLENA *lacustris. The lake Diglena.*—Body stout, oval, crystalline; the front straightly truncated; foot suddenly attenuated, in length one-fourth of the body; the toes one-third the length of the foot. The transparency of this animalcule is often a great hindrance to the discrimination of its internal organs, though they are very large; the superficial skin is delicately shagreened. *Fig.* 403 represents a side view (left) of this interesting animalcule, with a Lynceus (see *Microscopic Cabinet, plate* vii.) in its stomach; its curious internal organization is clearly depicted. Often found in green-coloured water. Length 1-70th.

629. DIGLENA *grandis. The elegant Diglena.*—Body long, slender, and cylindrical, obliquely truncated anteriorly; toes straight, longer than the stout foot. The forked central sacculi, between the two ocular ganglia, is remarkable. *Fig.* 404 represents a side view (right) of an extended animalcule; *fig.* 405 another, contracted, with the jaws pushed out. Length 1-120th to 1-72nd.

630. DIGLENA *forcipata* (*Vorticella vermicularis, Cercaria forcipata et vermicularis,* M.) *The bent-fingered Diglena.*—Body cylindrical, slender, obliquely truncated

anteriorly; toes decurved, and longer than the stout foot. Length 1-110th.

631. DIGLENA (?) *aurita* (*Vorticella canicula*, M.) *The long-eared Diglena.*—Body cylindrical, slender; front straightly truncated, auricled; foot suddenly constricted, toes small. The tremulous organ (heart) observed by Corti was merely the vibratile lining membrane of the anterior portion of the alimentary canal. Found amongst conferva. Length 1-160th.

632. DIGLENA *catellina* (*Cercaria catellina*, *Vorticella larva*, M.) *The little dog Diglena.*—Body oblong, short, ends truncated; foot short, and inferior. The small size of this animalcule is unfavourable for observing its internal organization. It is found at all seasons of the year in open water and infusions, covered with a green pellicle, which is often filled with its eggs; these, when rapidly developed by genial weather, cause a milky turbidity in the water. Length 1-360th.

633. DIGLENA *conura*. *The long-cone Diglena.*—Body ovato-oblong, straightly truncated in front, and gradually attenuated to a conical foot. Found amongst oscillatoria. Length 1-144th.

634. DIGLENA *capitata*. *The great-headed Diglena.*—Body oblong, conical, obliquely truncated, and dilated in front; toes long, without apparent base, or foot. This animalcule feeds upon Chlamidomonas and Naviculæ. Length 1-300th.

635. DIGLENA *caudata* (*Vorticella furcata*, M.) *The long-tailed Diglena.*—Body elongated, conical, obliquely truncated anteriorly, but not dilated; foot distinct, short; toes long. Found in green water. Length 1-200th.

Genus CLIX. TRIARTHRA. *The three-bearded Rotatoria* possess two frontal eyes; a simple styliform foot, and beard, or breast fins. Beside the vibratile organs, internal band-like muscles are observed, and two bristles, or fins, which assist in leaping; these remind us of Polyarthra. The nutritive apparatus consists of an œsophagal head, having four muscles, and two double-toothed jaws, as in Rotifer; an œsophagal tube, long in one species, short in the other; and a simple, conical, or constricted alimentary canal, with two spherical glands. Both ovarium and contractile vesicles are seen; the eggs, when expelled, remain attached by threads. A vascular system is unknown—the nervous is indicated by the two red eyes, placed upon ganglia. Both species often produce a milky turbid appearance in the water, when developed in masses.

636. TRIARTHRA *longiseta* (*Trichoda*, M.) *The long-bearded Triarthra.*—Eyes distant, the cirri, or beards, and the foot, are nearly three times the length of the body. This species is distinguished from the following one by the greater length of cirri, by larger eyes, which are further removed from each other; by a distinct stomach, with a constriction separating it from the long portion of the alimentary canal; and, lastly, by its long œsophagal tube. It is readily distinguished by its leaping movement whilst swimming. *Fig.* 408 represents one of these creatures emerging from the egg, the cirri or styles being, as yet, soft: *fig.* 407 is a back view of a young specimen; it shews the great separation of the eyes and the styles, in the position they take when the animalcule is swimming; and *fig.* 406 is a side (right) view of a full-grown specimen; the

styles are advanced, which is the case when preparing to leap. Found with Hydatina senta and Brachionus urceolaris. Length, without cirri, 1-140th.

637. Triarthra *mystacina* (*Brachionus passus,* M.) *The short-bearded Triarthra.*—Eyes close together; two anterior cirri, or bristles, and foot, nearly double the length of the body; jaws very soft. Found in water-tubs. Length 1-216th.

Genus CLX. Rattulus. *The rat Rotatoria* have two frontal eyes, and a simple styliform foot, but no cirri, or beard. Several undefined rotatory muscles, an œsophagal head, without distinct teeth or œsophagal tube, a simple conical alimentary canal, with two round glands, an ovarium, and eyes, comprise the organization at present discovered.

638. Rattulus *lunaris* (*Trichoda lunaris,* M.) *The sickle-shaped Rattulus.*—Body small; eyes remote from the frontal margin; foot decurved, lunate. No teeth are seen. *Group* 409 represents two of these animalcules. Found in turfy pools. Length 1-288th.

Genus CLXI. Distemma. *The double-star Rotatoria* have two cervical eyes and a forked foot; the vibratile organ is compound. The nutritive apparatus consists of an œsophagal head, which in three species has jaws, with two teeth each; in one species more than two, a short œsophagal tube, and a simple conical alimentary canal, with two spherical glands. The reproductive organs are an ovarium, and in D. (?) marinum sexual glands and a contractile vesicle. No satisfactory details of a vascular system are ascertained, but that of sensation is illustrated by the presence of eyes, which are red, except in one species, in

which they are colourless. In all the species, except D. marinum, the eyes are situated behind the head of the œsophagus, but in that they are anterior, but below the rotatory organ. The eggs are never attached to the parent, nor are they developed in large masses.

639. DISTEMMA *forficula. The pincer-foot Distemma.*—Body cylindrico-conical; eyes red; toes thick, recurved, and dentated at the base. The eyes are placed at the end of a long cylindrical nervous ganglion, and the rotatory organ consists of four parts. *Fig.* 411 is a side (left) view, and *fig.* 410 shews the jaws extended for seizing its prey. Length 1-120th.

640. DISTEMMA *setigerum. The bristle-footed Distemma.*—Body ovato-oblong; eyes red; toes setaceous and decurved. Length 1-216th.

641. DISTEMMA (?) *marinum. The sea Distemma.*—Body ovato-conical; eyes red, close together; foot long; toes thick, the length of the foot; jaws many-toothed. Found in sea water. Length 1-144th.

642. DISTEMMA (?) *forcipatum. The colourless Distemma.*—Body ovato-oblong; eyes colourless; foot short, with stout toes. If the two colourless vesicles are not eyes it must be placed in the genus Pleurotrocha. Length 1-288th.

Genus CLXII. TRIOPTHALMUS. *The row-eyed Rotatory Animalcule* has three cervical eyes, which are sessile, and are all arranged in a row, and a forked foot. The rotatory organ is compound. It has a large œsophagal head, with two (single toothed?) jaws, a long thin œsophagus, a globose stomach-like protuberance, with two oval glands, and thin posterior alimentary canal; two muscles move the foot.

643. TRIOPTHALMUS *dorsualis*.—Body crystalline, turgid; foot suddenly attenuated, its length half the body. This species, in form, resembles Notommata ansata, but in size N. myrmeleo. *Fig.* 412 represents (dorsal side) an animalcule extended as it appears when swimming and vibrating; *fig.* 413, another in the act of unfolding itself; and *fig.* 414, another specimen, contracted. Length 1-40th.

Genus CLXIII. EOSPHORA. *The three-eyed Rotatoria* have three sessile eyes, two frontal, the one cervical, and possess a forked foot. The rotatory organ is composed of numerous muscular portions, and distinctly-striated longitudinal muscles are seen in all. An œsophagal head, provided with two single toothed jaws, a short œsophagus, a simple conical alimentary canal, with two ovate glands anteriorly, an ovarium, somewhat extended, sexual glands, and a contractile vesicle, are also to be found. Transverse vessels are observable in two species, in the third gills. No respiratory tube has been discovered. Beside the three red coloured eyes a cerebral ganglion is seen.

644. EOSPHORA *najas*. *The aurora Eosphora*.—Body conical, transparent, not auricled; toes much shorter than the foot. The name Aurora is derived from the red colour of the eye. *Fig.* 415 represents an animalcule fed upon indigo. Found amongst conferva. Length 1-120th.

645. EOSPHORA *digitata*. *The long-fingered Eosphora*. —Body conical, hyaline, not auricled; toes a third the length of the foot. Found amongst conferva. Length 1-96th.

646. EOSPHORA *elongata*. *The slender Eosphora*.—Body elongated, almost fusiform, not auricled, front truncated; toes short. Length 1-72nd.

Genus CLXIV. Otoglena. *The pedicle-eyed Rotatory Animalcule* is characterized by having three eyes, one being sessile and cervical, the others pedicled and frontal; it possesses a furcated foot. This large animalcule has considerable resemblance to Notommata myrmeleo or clavulata, but is very distinct. As regards the detail of its organization, it may be stated that four lateral longitudinal muscles, six vibratile muscles, and two muscles of the foot, are present; a toothless, and apparently jawless, œsophagal canal, leads to a somewhat thickened stomach, having a very thin posterior alimentary canal. Ovarium, contractile vesicles, and two sexual glands exist. In the middle of the back appears to be a respiratory opening; this, with a vascular network at the neck, and four transverse circular canals, represent a vascular system. An oval cerebral ganglion, with two dark appendages, a red eye, a long nervous loop on the neck, that runs back to a second ganglion in the brow, and a forked ventral nerve (?), together with two little horn-like or auricular frontal protuberances, bearing two visual points, represent the sensitive system. This genus has not been figured.

647. Otoglena *papillosa. The warty Otoglena.*—Body bell-shaped, turgid, scabrous through papillæ. Found with Volvox globator and Notommata myrmeleo. Length 1-96th.

Genus CLXV. Cycloglena. *The ring-eyed Rotatoria* have numerous eyes (more than three), simply conglomerate at the neck, and the foot furcated. The vibratile organ is compound; this organ, with the internal muscles of the foot, compose the locomotive structure. They have an œsophagal head, with two single-toothed (perhaps three-

toothed) jaws, a very short œsophagus, and a simple conical alimentary canal, with two roundish glands. Both ovarium and two sexual glands, with a contractile vesicle, are found. Transverse circular vessels, and six pair of tremulous organs, attached to the seminal glands, constitute the vascular system. A purse-shaped dark (colourless) body in the neck, connected by a narrow process to a large frontal ganglion, containing from six to twelve red points, of which the anterior one is most marked, indicate a sensitive system.

648. Cycloglena *lupus* (*Cercaria lupus*, M.) *The water-wolf Cycloglena.*—Body ovato-oblong, or conical, not auricled; foot terminal, and short. *Plate* x., *fig.* 425*, represents a back view, and *fig.* 426 a side view. Length 1-120th.

649. Cycloglena (?) *elegans. The elegant Cycloglena.* —Body ovate, not auricled; foot inferior; toes long. Length 1-190th.

Genus CLXVI. Theorus. *The many-eyed Hydatinaea* have numerous eyes (more than three), disposed in two groups at the neck; the foot is furcated. A compound rotatory organ, together with two muscles of the foot, an œsophagal head, with two one-toothed jaws, a short œsophagus, a simple conical alimentary canal, with two glands, a ball-like ovarium, with two male sexual glands, and a double group of colourless cervical eyes, are the details of organization at present known. The frontal uncinus, or hook, is perhaps a respiratory tube.

650. Theorus *vernalis. The spring Theorus.*—Toes small; no frontal uncinus. The movement of this creature is active and vehement, like that of an animal of

prey. *Fig.* 427 represents a back view of this animalcule extended, with six colourless eyes in each group ; *fig.* 428 is another specimen with four eyes ; and *fig.* 429 an animalcule with body contracted, but jaws extended. Found amongst oscillatoria. Length 1-140th.

651. THEORUS *uncinatus. The hook-lipped Theorus.*—Toes long, a frontal uncinus or hook present. Six visual points have been seen by Ehrenberg. Found amongst oscillatoria. Length 1-240th.

Family XXVIII.—EUCHLANIDOTA

Comprehends Rotatoria whose rotatory organ is compound, being divided into several parts, always more than two, and which, moreover, possess a lorica. This shell-like covering, says Dr. E., resembles either that of tortoises or crabs; the former when open only at the ends (*testa testula*), the latter when open also on the under side, or back, forming a little shield (*scutellum*). As appendages, we find setæ in Euchlanis and Stephanops; uncini in Colurus; little horns in Dinocharis; spurs, or respiratory tubes, in Euchlanis and Salpina; and a hood in Stephanops. They all possess a foot, mostly furcated, very few being simple and styliform. Of the whole, only three species are destitute of eyes. Separated muscles for moving the rotatory organs exist in all the genera, and internal free ones in three species of the genus Euchlanis; muscles for moving the foot are also to be seen. The nutritive apparatus consists of a muscular œsophagal head, with two jaws provided with teeth; these are free (*gymnogomphia*) in all the species examined. They have a very short œsophagus. Eight genera have either a simple conical stomach (*coelogastrica*) to their alimentary canal, or else one produced by a constriction (*gasterodela*). Two round or ovate intestinal glands are also seen. The discharging opening is at the base of the foot, upon the dorsal surface, which latter is clearly indicated by the situation of the eyes, when present. The ovarium developes but few large ova at a time; two sexual glands and a contractile vesicle exist in the genera Euchlanis, Monostyla, Stephanops,

and Squamella—the latter organ only in Metopidia, Lepadella, and Mastigocerca. They do not carry their ova externally. Traces of a vascular system are seen in two species of Euchlanis, and perhaps also the gills in Dinocharis, and the respiratory tube in Salpina and Euchlanis must be included. The nervous system is indicated in ten genera by the presence of red visual points, whose situation and number are useful to establish generic characters; an evident cerebral ganglion (as a nervous layer to the eyes) is found in Euchlanis, Monostyla, Mastigocerca, and Salpina. The genus Lepadella developes itself occasionally in such myriads, in stagnant water, as to give a whitish turbidity to it.

The genera are disposed as follow:—

- No eyes, foot furcated .... Lepadella.
- Eyes present.
  - one eye (cervical.)
    - foot styliform
      - lorica depressed .... Monostyla.
      - lorica prismatic .... Mastigocerca.
    - foot furcated
      - lorica gaping beneath .... Euchlanis.
      - lorica closed beneath.
        - lorica horned...... Salpina.
        - without horns .... Dinocharis.
  - two eyes (frontal.)
    - foot styliform .... Monura.
    - foot furcated
      - lorica compressed laterally or cylindrical Colurus.
      - lorica depressed or prismatic
        - head not hooded .. Metopidia.
        - head hooded ...... Stephanops.
  - four eyes, foot furcated........ Squamella.

Genus CLXVII. Lepadella. *The scaled Rotatoria* are devoid of eyes, but possess a furcated foot. Several rotatory muscles are seen, and foot ones in two species. The jaws of the œsophagal head are single-toothed in L. ovalis and emarginata; in salpina, triple-toothed. The

tube of the œsophagus is very short in all. The alimentary canal is constricted, except in Salpina, which is simple. The ovarium is globular in all, and a male sexual vesicle is present in Salpina, in which species, probably, a cerebral ganglion (no eye). L. ovalis is sometimes developed in myriads in stagnant water.

652. Lepadella *ovalis* (*Brachionus ovalis*, M.) *The egg-shaped Lepadella.*—Lorica depressed, oval, attenuated anteriorly, the ends truncated: it is not emarginate. The alimentary canal of this animalcule is generally filled with a yellowish substance, except when it feeds upon colourless Monads. *Fig.* 430 represents a back view; *fig.* 431 a side (right) view of a young specimen; *fig.* 432 the lorica; *fig.* 433 the œsophagal head. Length 1-240th.

653. Lepadella *emarginata* (*Brachionus spatella et ovalis*, M.) *The emarginate Lepadella.*—Lorica depressed, oval, broad anteriorly, extremities emarginate. Found amongst conferva. Length, without foot, 1-576th.

654. Lepadella (?) *salpina. The stock-fish Lepadella.*—Lorica oblong, prismatic, obtusely triangular, back crested, anterior denticulated. Found amongst conferva. Length of lorica 1-200th.

Genus CLXVIII. Monostyla. *The spinous-footed Rotatoria* possess a single cervical eye, a simple styliform foot, and a depressed lorica (*testula*). Numerous rotatory muscles are seen in two species, and also an œsophagal head, having four muscles; in one species the jaws are single-toothed, in the other two-toothed. They have a very short œsophagus, and a constricted stomach (*gasterodela*), with two glands. The ovarium is globular; an ovum, with the vesicle of the germ within it, is seen in two

species. No male organs, vessels, nor respiratory tubes, are seen. Owing to the almost constant vibration of the foot-like tail, it is difficult to observe the true form of its termination, the motion producing an optical deception; hence it appears double, though in reality it is single.

655. MONOSTYLA *cornuta* (*Trichoda cornuta,* M.) *The smooth Monostyla.*—Lorica hyaline, unarmed, and truncated anteriorly. Found amongst chara and conferva. Length 1-250th.

656. MONOSTYLA *quadridentata. The four-horned Monostyla.*—Lorica yellowish, the anterior deeply dentated, resembling four horns. It is generally of a yellow leather colour, but Ehrenberg has seen it colourless. *Figs.* 434 and 435 represent ventral views of this animalcule; the latter is extended beyond its lorica, which happens when the rotatory cilii are in motion. *Fig.* 436 is a side view, and *fig.* 437 the jaws and teeth separate. Found in floccose matter about conferva and the leaves of water-plants. Length 1-120th.

657. MONOSTYLA (?) *lunaris. The moon-shaped Monostyla.*—Lorica hyaline, the anterior crescent-shaped. Length 1-144th.

Genus CLXIX. MASTIGOCERCA. *The whip-tailed Rotatory Animalcule* is characterized by its having a single cervical eye, a simple styliform foot, the lorica prismatic and crested on the back. It has a four-partile rotatory organ, a small muscle to move the foot, an oblique œsophagal head, with unequal jaws, two-toothed; a short œsophagus, simple intestine, with two spherical glands, a globular ovarium, a contractile vesicle, and a long ganglion.

658. MASTIGOCERCA *carinata* (*Trichoda rattus*, M.) *The flesh-coloured Mastigocerca.*—Lorica anteriorly crested on the back; foot the same length as body; it swims slowly, and resembles Monocerca rattus. *Figs.* 438, 439, are side views, showing the delicate ridge of the lorica projecting on the back, and *fig.* 440 a dorsal view. Found amongst Ceratophyllum. Length 1-72nd.

Genus CLXX. EUCHLANIS. *The mantle Rotatoria* have a single cervical eye, a furcated foot, and the lorica longitudinally gaping upon the ventral surface. Compound vibratile muscles, with their cilii, compose the rotatory organ: the other muscles are those for moving the foot, for manducation, and fibrous longitudinal ones, the latter presenting transverse corrugations. An œsophagal head, with one or many-toothed jaws (perhaps four jaws in E. macrura), (*gymnogomphia*); a very short œsophagus, an alimentary canal (simple in five species, constricted in one), having two glands, compose the nutritive apparatus; an ovarium is observed in five species, and two small glands, with a contractile vesicle, in two of the larger species. As parts of a vascular system, two species have perhaps transverse vessels, and in the larger forms tremulous gills are observed, attached to the sexual glands; a respiratory tube is seen in E. lynceus only. As organs of sensation, all the species have a red-coloured cervical eye, which, in five species, is connected with a large ganglion. They do not carry about their eggs externally, nor are they developed in large numbers.

659. EUCHLANIS (?) *triquetra. The three-edged Euchlanis.*—Lorica very large, trilateral from a dorsal crest, foot setæ none. This species is very diaphanous, and

"therefore," remarks Ehrenberg, "I was never able to see the line of division on the ventral surface of the lorica; the relationship of the fibres of the lateral muscles is physiologically and anatomically interesting: they form three bundles upon each side, and show as distinct corrugations, as do the muscles of larger animals." *Fig.* 443 represents a fore-shortened view. *Fig.* 442 is a left side view, shewing the dorsal crest of the lorica. At the base of the foot an external empty fold of the skin is visible. *Fig.* 441 represents the ventral surface, and exhibits an opening for the foot, but no visible division of the lorica is seen. *Fig.* 444 shows the teeth and jaws separate. Found in turf pools. Length 1-48th; ovum, 1-192nd.

660. Euchlanis (?) *Hornemanni. Hornemann's Euchlanis.*—Lorica thin, short, cup-shaped, truncated in front, the anterior part of the body soft (pliant) and elongated. This creature appears able to draw within the lorica both foot and head. Sometimes longitudinal muscles are apparent, and Ehrenberg has seen three delicate parallel transverse lines, which he states to be vessels. Length 1-432nd to 1-240th.

661. Euchlanis *luna* (*Cercaria luna*, M.) *The moon-shaped Euchlanis.*—Lorica cup-shaped, the front excised in a lunate manner, toes with claws. The single-toothed jaw, the constriction of the alimentary canal, and the claws, distinguish it from the other species. Found amongst Ceratophyllum and conferva. Length 1-144th.

662. Euchlanis *macrura. The long-footed Euchlanis.*—Lorica large, ovate, depressed; bristles at the base of the foot; toes long, styliform. This species is distinguished from the following one by its stronger and longer toes.

"Lately," says Ehrenberg, "I saw the division of the lorica along the ventral surface." Each jaw has five teeth, and there are two soft maxillary appendages, each with two teeth. Found amongst conferva, in clear water. Length, without foot, 1-96th.

663. Euchlanis *dilatata* (*Brachionus*, M.) *The broad Euchlanis.*—Lorica broad, depressed, folded on the under side; foot without setæ, toes long. This animalcule, when it emerges from the egg, has a very soft lorica, and resembles Notommata. Length of lorica 1-96th.

664. Euchlanis *lynceus.* *The lynceus-like Euchlanis.*—Lorica ovate, turgid, deeply fluted; two little horns project anteriorly. *Fig.* 445 represents a back view, and 446 a side view; the lorica is open along the middle of the under side. Length of lorica 1-216th.

Genus CLXXI. Salpina. *The stork-fish Rotatoria* possess a single cervical eye, a furcated foot, a lorica closed below, and terminated by spine-like processes or teeth. "The lorica," says Dr. Ehrenberg, "resembles a three-sided little casket, with arched sides, flat below, and having anteriorly and posteriorly, at the truncated extremities, little points." The animalcule can entirely withdraw itself within the lorica. All the species have an elevated ridge upon the back, which in two species appear to be double. (Ehrenberg is somewhat inclined to think the lorica is open its whole length upon the dorsal surface.) A compound rotatory organ, two short anterior lateral muscles, and two foot muscles, in S. mucronata, are seen, as locomotive agents. An œsophagal head, with three or four toothed jaws, a short œsophagus, and a simple conical alimentary canal, exist in all the species; in five species

the latter has two spherical glands; an ovarium is seen, but no male structures; a respiratory spur or tube is observed at the neck in three species; the red eye in connexion with a cerebral ganglion is always present. They do not increase in large masses.

665. SALPINA *mucronata* (*Brachionus mucronatus*, M.) *The short-spined Salpina.*—Lorica very minutely scabrous, anteriorly four and posteriorly three-horned; these are generally straight, and of equal length. The lorica, when the creature is young, is soft and bent, but soon hardens, and has horns. The spur, or respiratory tube, in the neck, terminates in a little bristle, as seen in *fig.* 450. In some specimens, Ehrenberg says, the lorica appears as if punctated or stippled. *Figs.* 447, 448, represent full-grown specimens, with the head withdrawn; the latter figure is a back view, the former an under one. *Fig.* 449 is a side view, head extended. *Fig.* 451 is an egg, just deposited on lemna; *fig.* 452 another egg, with the young vibrating; and *fig.* 450 another just escaped from the shell; *fig.* 453 represents the teeth separately. Length of lorica 1-144th.

666. SALPINA *spinigera*. *The thorny Salpina.*—Lorica horned, four frontal, three posterior; the posterior dorsal horn longest, and a little recurved. Glands on the alimentary canal not observed. Found amongst Ceratophyllum. Length of lorica 1-140th.

667. SALPINA *ventralis*. *The long-spined Salpina.*—Lorica stippled, horns two in front, three posterior, the dorsal one short and decurved. Found amongst conferva, &c. Length 1-120th.

668. SALPINA *redunca*. *The uncinated Salpina.*—Lorica smooth, horns two in front, three behind, two of the

latter (the under ones) hooked, the dorsal crest bifid and gaping; it has four teeth to each jaw. Found amongst conferva. Length 1-200th.

669. SALPINA *brevispina.* *The short-horned Salpina.*—Lorica scabrous, horns two (small) in front, and three behind, short dorsal crest not gaping; lorica milky and turbid, but appearing bright; respiratory tube unknown. Found amongst Ceratophyllum. Length 1-144th.

670. SALPINA *bicarinata.* *The double-combed Salpina.*—Lorica smooth, horns four in front, three posterior, short; neither lateral muscles nor respiratory tubes known. Length 1-216th.

Genus CLXXII. DINOCHARIS. *The goblet Rotatoria* are provided with a single cervical eye, a furcated foot, and a lorica closed below, and unarmed at both ends. The compound rotatory organ has five or six muscles, and the foot two in two species. An œsophagal head with single-toothed jaws is found, except in D. tetractis, which Dr. E. thinks has four teeth; œsophagus very short, alimentary canal constricted, except in D. pocillum (*gasterodela*), which is constricted: two oval glands exist in D. pocillum and tetractis. Glandular portions of ovarium are seen in all, and a contractile vesicle at the base of the foot in D. pocillum. Traces of a vascular system are perhaps to be seen in D. pocillum, though even here it is doubtful, for the apparent tremulous organ just behind the œsophagus may be only a tremulous condition of an internal fold of the stomach. The only evidences of a nervous system are the eye and the long ganglion which supports it.

671. DINOCHARIS *pocillum* (*Trichoda pocillum,* M.) *The five-pointed Dinocharis.*—Lorica nearly cylindrical;

two long spines at the base of the foot; toes three: it has a slight dorsal ridge. *Figs.* 454, 455, represent this creature in different positions; and *fig.* 456 the œsophagal head. Found amongst Ceratophyllum, &c. Length 1-120th.

672. Dinocharis *tetractis.* *The four-pointed Dinocharis.*—Lorica acute, triangular; horns two, at the base of the foot; toes two. This species has longer toes than the others, and the body is comparatively shorter. Found in lemna and Ceratophyllum. Length 1-120th.

673. Dinocharis *paupera.* *The simple Dinocharis.*—Lorica acute, triangular; horns two, at the base of the foot, scarcely perceptible, toes two, short. Length 1-120th.

Genus CLXXIII. Monura. *The styliform-footed Rotatoria* have two frontal eyes, and a simple styliform foot. The lorica is somewhat compressed and open upon the ventral surface: anteriorly is a hook-like process, which can be withdrawn. In one species the vibratile organ has four to six muscular bulbs; in both an œsophagal head, with two jaws toothed, a very short œsophagus, and a simple alimentary canal, with two spherical glands, are observed; also, an ovarium, with single large ova, and in one species the vesicle of the germ has been observed. The eyes are red, moveable, and seated upon nervous masses. The species are not only difficult to distinguish from each other, but also from the genus Colurus; the toes of the latter appearing single until pressure is used.

674. Monura *coluris.* *The obtuse Monura.*—Lorica oval, obtuse, obliquely truncated posteriorly, eyes near to each other. Length of lorica 1-280th. Siberian specimens, 1-400th.

675. Monura *dulcis.* *The pointed Monura.*—Lorica

ovate, anterior acute, posterior obliquely truncated; eyes distant from each other; the alimentary canal is often filled with green matter. They increase rapidly in glass vessels. *Figures* 457 to 459 represent three views of this animalcule. Found amongst conferva. Length of lorica 1-288th.

Genus CLXXIV. COLURUS. *The pincer-footed Rotatoria* have two frontal eyes, a furcated foot, and a compressed or cylindrical lorica. The lorica is open upon the under side (*scutellum*); this is distinctly seen in four species: a compound rotatory organ is present in all, over it projects a retractile frontal hook (respiratory tube); an œsophagal head with two jaws, these in two species have two or three teeth; œsophagus very short; two species have a constricted stomach (*gasterodela*), the others have a simple alimentary canal (*coelogastrica*), with glands to all. The red frontal eyes are delicate; in C. uncinatus and bicuspidatus they have escaped observation; all have peculiar vesicles at the back. They resemble Monura.

676. COLURUS (?) *uncinatus* (*Brachionus uncinatus*, M.) *The little-horned Colurus.*—Lorica ovate, compressed, posterior and bi-pointed toes, very short; at the middle of the back is generally a circlet of vesicles, which at one time Ehrenberg considered eyes, but now he regards them as vesicles of oil, as they are seen in all the species, and abundantly in the Cyclopides. Found both in fresh and sea water. Length 1-430th to 1-288th.

677. COLURUS (?) *bicuspidatus.* *The large Colurus.*—Lorica ovate, compressed, the two points posteriorly strong, toes short. Length 1-288th.

678. COLURUS *caudatus.* *The long-fingered Colurus.*—Lorica ovate, compressed, posterior points distinct; toes

longer than the foot. The shell resembles C. uncinatus, but the toes are much longer. Found both in fresh and sea water. Length of lorica 1-288th.

679. Colurus *deflexus*. *The winged Colurus.*—Lorica ovate, compressed; the shell is more rounded and very transparent. *Figures* 460 to 462 represent back, under, and side views; the former shews the vesicles. Found in the clear water of a peaty moor. Length 1-240th.

Genus CLXXV. Metopidia. *The frontal eyed Rotatoria* have two eyes in front, a furcated foot, and a depressed or prismatic lorica, the frontal portion of the body being naked or uncinate (not provided with a hood); indeed they may be termed Lepadella, with two red frontal eyes; the lorica appears to be closed on the under side (*testula*). In two species the rotatory organ has from three to four muscles, and in one species two foot muscles are observed. Two species have a frontal hook (respiratory tube), like Colurus. The œsophagal head in one species has two, in another four, but in the third no distinct teeth; a short œsophagus, and two spherical glands, are present in all. Two species have a distinct constricted stomach (*gasterodela*). An ovarium is present, and M. triptera has a contractile vesicle.

680. Metopidia *lepadella*. *The flat Metopidia.*—Lorica depressed, nearly flat, broadly ovate, excised in a lunate manner in front, rounded posteriorly; toes somewhat longer than foot. This species resembles in form Lepadella ovalis (*fig*. 207) and Squamella bractea, but is distinguished from the former, which has two-toothed jaws and no eyes; from the latter, which has four eyes and indistinctly-toothed jaws. *Figures* 463 to 465 represent

different views of this animalcule—viz., back, under, and side, the first and last having the rotatory organs extended and in motion. Length 1-140th.

681. Metopidia *acuminata*. *The pointed Metopidia.*—Lorica depressed, nearly flat, oval in shape, anterior slightly excised, posterior pointed. This species resembles Colurus, but, in the latter genus, the eyes are very close together, and the lorica open beneath. Found amongst oscillatoria. Length 1-240th.

682. Metopidia *triptera*. *The three-sided Metopidia.*—Lorica oval, triangular, back crested: a section would resemble *fig.* 443. Found amongst conferva. Length 1-200th.

Genus CLXXVI. Stephanops. *The diadem or coronet Rotatoria* have two eyes in front, the foot furcated, the lorica depressed or prismatic, and the front provided with a hood or diadem. The lorica, in two species, has thorn-like processes posteriorly. In one species a longitudinal muscle is observed on each side (anteriorly), two muscles for moving the foot, and from three to five belonging to the compound rotatory organ. They have an œsophagal head, with single-toothed jaws, and a short œsophagus. One species has a two-partite alimentary canal, the others a simple one; two species have glands; an ovarium exists in all; a contractile vesicle in two. The red eyes are situated on each side, near the frontal edge in two species; in one they are yet unknown. The hood remains extended, even when the creature withdraws within its shell.

683. Stephanops *lamellaris* (*Brachionus lamellaris,* M.)—*The tri-pointed Stephanops* has a lorica with three spines posteriorly. The rapid movement and transparency of this animalcule renders its organization difficult to observe.

Figures 466, 467, represent different views of this creature, with its crystalline hood or diadem. Found amongst conferva. Length of lorica about 1-300th.

684. Stephanops (?) *muticus. The thornless Stephanops.*—Lorica unarmed posteriorly, entire. Ehrenberg remarks it is active, and that he has not seen the eyes satisfactorily. Length 1-144th.

685. Stephanops *cirratus* (*Brachionus cirratus,* M.) *The two-pointed Stephanops.*—Lorica with two spines posteriorly. This species has a contractile vesicle. Length 1-240th.

Genus CLXXVII. Squamella. *The four-eyed Euchlanidota* have four frontal eyes, and a furcated foot. The lorica is closed (*testula*), and the rotatory organ consists of five or six muscular bulbs. In one species the œsophagal head has jaws, with two or three teeth each. The œsophagal tube in one is short, in the other long, and bent like the letter S. Both have a two-partite intestine (*gasterodela*), with small glands, also an ovarium and contractile vesicle. The eyes are disposed in pairs on each side the brow.

686. Squamella *bractea* (*Brachionus bractea,* M.) *The crystal Squamella.*—Lorica depressed, broadly ovate. It is very transparent; the toes thick and short, not evident. Length of lorica 1-144th.

687. Squamella *oblonga. The elongated Squamella* has a depressed lorica, either elliptical or ovato-oblong, hyaline, toes long and slender; the eyes are larger than in the foregoing species. *Figures* 468, 469, represent back and side views of this animalcule. Found in green-coloured water, with Chlamidomonas pulvisculus. Length of lorica 1-280th.

Family XXIX.—PHILODINAEA.

This family comprehends Rotatorial Animalcules devoid of lorica, but possessing two simple rotatory organs, resembling wheels. The body of most species is worm-like, or spindle-shaped (fusiform). Portions of the body can be thrust in and out, like the tubes of a telescope slide, within each other; this is produced by a sort of false joint, caused by a peculiar insertion of the muscles. In all the species the foot is furcated, and in Callidina, Rotifer, Actinurus, and Philodina, it is provided with soft processes, resembling, in shape, horns, near the false joints, as in the genus Dinocharis (*fig.* 455). Muscles are seen in the genera just named. The nutritive apparatus consists of an œsophagal head, with two jaws; in three genera they are double-toothed (*zygogomphia*); in two the teeth are in rows (*lochogomphia*). In the four principal genera the alimentary canal is filiform; it is furnished with a bladder-like expansion at its commencement (*trachelocystea*), and surrounded by a turbid cellular or glandular mass. In one genus the alimentary canal is conical (*coelogastrica*), and, in the two African genera, is unknown. In four genera the intestine has glands; in a like number the propagative system is hermaphroditic, an ovarium, male glands, and contractile vesicle being present; the latter only, however, in Rotifer and Philodina, which, together with Actinurus, are sometimes viviparous. In Rotifer and Philodina portions of a vascular system are visible, in the form of from nine to twelve transverse vessels; these, as also Actinurus and Monolabis, have spur-like respiratory tubes. In thirteen

species red eyes are present, and beneath these organs only is nervous matter apparent.

The genera are disposed as follow:—

Eyes absent.	proboscis and foot processes present			Callidina.
	no proboscis or horn-like processes	rotatory organ pedicled		Hydrias.
		rotatory organ not pedicled		Typhlina.
Eyes present.	two frontal	foot having horn-like processes	toes two	Rotifer.
			toes three	Actinurus.
		foot without horn-like processes, toes two		Monolabis.
	two cervical			Philodina.

Genus CLXXVIII. Callidina. *The beautiful Rotatorial Animalcule* is characterized by wanting visual organs, and by possessing a proboscis, and a foot, furnished with processes resembling horns. The vibratile, or rotatory organ, is double, but not pedicled; anteriorly is a thickly-ciliated proboscis. The furcated foot has two elongated toes, four little horns or processes, and six points. Two muscles for moving the foot are also visible. The œsophagal head has two jaws, with numerous delicate teeth. The filiform alimentary canal has a bladder-like expansion posteriorly, but is not provided with glands; it is surrounded by a granular and cellular mass, whose function is unknown: Ehrenberg thinks it is connected with reproduction; an ovarium, with single large ova, is seen; a little spur-like process, projecting from the neck, may be a respiratory tube; no indication of a nervous system is observable.

688. Cāllidina *elegans*. *The graceful Callidina.*—Body spindle-shaped, crystalline; rotatory organs, or wheels, small. *Figs.* 470 to 472 represent this animalcule

in different states of extension or contraction. *Fig.* 473 shews the eggs. Found in bog water and infusions of oak bark. Length 1-72nd.

Genus CLXXIX. Hydrias. *The Water-turner* is African, and characterized by its being devoid of eyes, proboscis, and little horn-like processes at the foot; the two small rotatory organs, or wheels, being supported on pedicles or arms. An œsophageal head, and an ovarium, with a large ovum, has been seen by Ehrenberg. The form is like a naked Pterodina.

689. Hydrias *cornigera.* *The Lybian Hydrias.*—Body ovate, hyaline; foot attenuated, resembling a furcate tail. *Fig.* 474 represents an animalcule extended. Found with oscillatoria, in standing water, from a small spring by Siwa, in the Oasis of Jupiter Ammon. Length 1-190th.

Genus CLXXX. Typhlina. *The blind Vibrator,* like the last, has an African locality; it is characterized by absence of eyes, proboscis, and horn-like processes at the base of the foot; its little wheels are sessile. It resembles a very small Rotifer, without frontal proboscis or eyes.

690. Typhlina *viridis.* *The green Typhlina.*—Body oblongo-conical, small: it is represented at *group* 475. Found by Drs. Hemprich and Ehrenberg in a pool near Cairo in Egypt, in such numbers as to colour the water green. Length 1-720th.

Genus CLXXXI. Rotifer. *The proboscised Rotatoria* have two eyes, placed upon the frontal proboscis; the foot provided with little horn-like processes, and the two toes bisulcated at their apices. A double rotatory organ (considered by Cuvier, and others, as a respiratory apparatus), furnished with muscles, is seen in all the species; also

longitudinal and foot muscles in three of them ; a furcated foot and horn-like processes in four species; in R. citrinus, the pincer-like portions of the foot appear to be tri-pointed; in R. erythraeus, they were seen to be drawn in. In four species a muscular œsophagal head, with jaws, each two-toothed, is seen ; in three species the alimentary canal is filiform, with a vesicular expansion at the extremity ; it has no œsophagal tube, but is surrounded by a cellular glandulose turbid mass ; one species has a conical, tubular, alimentary canal, without the surrounding mass or expansion at the end ; the four European species have two spherical alimentary glands, and an ovarium, with a few large ova ; occasionally these species are viviparous. In three of them a contractile vesicle is present. In R. macrurus, near the alimentary canal, are two sexual glands. In three species from nine to twelve parallel transverse vessels have been observed by Ehrenberg ; and besides these, in the four European species, styliform respiratory tubes, emanating from the neck, which in one species are ciliated anteriorly. The indications of a nervous system are two red frontal eyes, in the four European forms ; and beneath them, in R. vulgaris, are two ganglia.

691. Rotifer *vulgaris* (*Vorticella Rotatoria*, M.) *The common wheel Animalcule.*—This creature, which was discovered by Leeuwenhoek, has a fusiform white body, gradually attenuated towards the foot, the eyes round. "This animalcule was described and illustrated in the *Microscopic Cabinet* some years ago, and prior to the appearance of Ehrenberg's observations on them ; it has the power of contracting or extending the length of the body in the following remarkable manner :—When the creature is about to

shorten itself, transverse folds or joints are observable, which do not appear to be confined in number or situation; the integuments, when a joint is produced, are drawn within the parts above, and slide out like the tubes of a telescope, when the joints disappear. It is this power that enables it to assume the form of a sphere, the head and tail being drawn within the body." Anteriorly it has a proboscis-like process, with a ciliated extremity, and a soft hook; near its end are two dark red points. The body terminates in a moderately-long tail-like foot, having six processes, disposed in pairs; two wreaths of cilii (the wheels), voluntarily moveable, are placed upon short thick arms (pedicled), which can be drawn in and out at pleasure; these wreaths serve for swimming and purveying, the food approaching it by the currents produced in the water by the cilii. On the dorsal surface is a styliform horn (*Speculum colare*, M.) destitute of cilii at its end. During vibration the neck has a circular fold, appearing like lateral styles. Four muscles, two anterior and two posterior, longitudinal, are seen; laterally, also, two club-shaped, for moving the foot, and two belonging to the rotatory organ. Sometimes, says Dr. Ehrenberg, four anteriorly longitudinal muscles, and a dorsal and ventral one, appear to be present. It has two kinds of locomotion, one by alternately attaching the mouth and foot, and, as it were, stepping along; the other by swimming, from the action of the rotatory apparatus. If the creature attaches itself by the foot, and the rotatory apparatus is in motion, a strong current or vortex is produced on each side the wheels, resembling two spirals in the water, which bring the nutritive particles to the mouth, from which some are chosen, and the rest

flow away. For observing this action with effect, finely divided carmine or indigo must be mixed in the water. The nutritive apparatus commences with a ciliated mouth, opening anteriorly, just beneath the hook-like proboscis: the cavity of the mouth is a long extensible tube, having posteriorly an œsophagal head, with four muscles, and two striated jaws with double teeth (*zygogomphia*). The œsophagus communicates with a filiform alimentary canal, which runs along the body, and has posteriorly an oval expansion near its opening, at the basis of the tail-like foot. A thick glandular cellulose mass, often yellowish or greenish, surrounds the alimentary canal; its use is unknown: Dr. Ehrenberg thinks it may be a cœcal appendage, or sexual glands: anteriorly are two biliary glands. The propagative system is very interesting: the ovarium is a globose glandular mass; in it four or five ova sometimes so completely develope themselves, that the young creep out of their envelopes, extend themselves, and put their wheels in motion while in it. They sometimes occupy two-thirds the length of the parent. In the ovum the young are disposed in a spiral bent manner: a sexual vesicle exists. The vascular system comprise eleven or twelve parallel transverse vessels, and the respiratory tube at the neck. The latter was formerly considered a sexual organ. The two red frontal eyes, with ganglion beneath them, are indications of a nervous system. These eyes are cells, filled with a granular pigment, which sometimes separate abnormally into several; so that Dr. Ehrenberg thinks no crystalline lens exists, but, it may be, they are compound, like the eyes of insects, to determine which will require a microscope possessing enormous penetrating

power; a quality discovered by Dr. Goring, and amply explained and illustrated in chapters xvi. and xvii. of the *Microscopic Cabinet*. *Fig*. 476 represents a full-grown animalcule extended, with the wheels vibrating, and shews the currents when indigo is put in the water; it is supposed to be attached to a fixed body. *Fig*. 477 is an under view of the same, with the wheels withdrawn, and the body contracted; *fig*. 478 is another, extended, but wheels withdrawn; this creature, as also *figures* 479 and 480, which represent the upper portions more highly magnified, have been submitted to different degrees of pressure between the plates of an aquatic crush-box. In *figures* 476 to 478 ova are seen, some are developed, and their eyes and œsophagal bulb visible. The respiratory transverse vessels and tube, projecting from the neck, are seen in the engravings.

The following interesting observations of Dr. Morren are extracted from the *Annals of Natural History*, vol. vi.:—

"The labours of Rœper show that the cells of Sphagnum are sometimes furnished with openings, which place their interior cavity in communication with the air, or water, in which they are immersed. This skilful observer satisfied himself that, when circumstances are favourable, the Rotifer vulgaris exists in the cells of the Sphagnum obtusifolium. This grew in the air, in the middle of a turf pit, but Rœper observed its leaves in water; he does not mention whether the infusorial animalcule came from thence, or whether it was previously contained in the cavities of the cells. The general purport of the paper seems to imply that these Rotiferi exist in the cells of that part of the plant which was exposed to the air, and, in this case, the

presence of an animal so complicated, living as a parasite in the cells of an utricular aërial tissue, is a phenomenon of the most curious kind in the physiology of plants, and the more so as this animal is an aquatic one.

"I recollected that the last year of my residence in Flanders, I found, near Ghent, the Vaucheria clavata, in which I observed something similar. M. Unger had already published the following details respecting this plant in 1828:—'Beneath the emptied tubercles, and at several points of the principal stalk, at different angles, rather narrower branches are produced; these branches are generally very long, and greatly exceed the principal stalk in length. At the end of ten or twelve days after their development, there are seen, towards one or the other of their extremities, here and there, at different distances from the summit, protuberances of a clavate form, more or less regular, straight, or slightly bent back; and others on the sides of the stalk, which have the form of a capsule, or vesicle. These vesicles are, at first, of a uniform bright green colour, and without increase of size, which exceeds several times that of the branches; they always become of a blackish-green colour, darker towards the base, and then one or two globules, of a reddish-brown, may be clearly distinguished there, often surrounded by smaller granules, evidently destitute of motion, whilst the great ones move spontaneously and slowly, here and there, in the interior of the capsule, by unequal contractions and dilatations, whence arise remarkable changes of form. I saw these globules at the end of eight or ten days after their appearance, still inclosed in the capsule, moving more and more slowly, receiving no very decided increase, whilst the base

of the capsule became more transparent; at last I observed that, instead of their expulsion, which I was watching for, the extremity of the capsule, at the end of some days, took an angular form, and subsequently gave birth to two expansions, in the form of horns; it remained in this state, and became more and more pale, whilst the animalcule became darker, and died, and afterwards it ended by perishing at the same time as the other parts of the conferva.'

"Subsequent researches have not succeeded in informing us what this animal might be of which Unger spoke. As this author drew so much attention to the spontaneous movement of the propagula of the Vaucheriae, and as he admitted the passage from vegetable life, characterized, according to him, by immobility, to animal life, the principal criterion of which was motion, his animalcule was confounded with the propagula; and no one, so far as I know, has returned to this very interesting subject.

"When, therefore, I found the Vaucheria clavata at Everghem, I was as much surprised as pleased to see the mobile body, noticed by Unger, better than he did: with the aid of a higher magnifying power, I found it easy to ascertain the true nature of the animal, for it is was not a propagulum, but a real animal, the Rotifer vulgaris, with its cilia, wheels, tail, &c.

"The first protuberances, or vesicles, which I saw, containing this animal, inclosed but one of them; afterwards they laid eggs, and multiplied; but it seems that then they descend the tubes of the Vaucheria, and lodge themselves in new protuberances, whose development they may possibly stimulate, as the galls and oak-apples are organic

transformations, attributable to the influence of parasitic beings.

"The Rotifer vulgaris travels quite at his ease in these protuberances; he traverses the partitions, displaces the chromule, and pushes it to the two extremities of the vesicle, so that this appears darker at these parts. One day I opened a protuberance gently; I waited to see the Rotifer spring out, and enjoy the liberty so dear to all creatures, even to infusorial animals, but no—he preferred to bury himself in his prison, descending into the tubes of the plant, and to nestle himself in the middle of a mass of green matter, rather than swim about freely in the neighbourhood of his dwelling.

"Some of these protuberances had greenish threads appended to their free end, and others had none; I thought at first that these threads were some *mucus* from within, escaped through some opening which might have served the Rotifer as an entrance, but an attentive and lengthened observation convinced me that in this there was no solution of continuity, and that the arrival of the Rotiferi in the Vaucheriae was not at all to be explained in this way. How are these parasitic animalcules generated within them? This is what further research has some day to show. Meanwhile I have thought that it should be made known that the animalcules found in the Vaucheriae, by Unger, was the Rotifer vulgaris of zoologists."

Found both in fresh and sea water, in infusions, on the floccy matters of water plants, &c. Length 1-50th to 1-24th.

692. ROTIFER (?) *citrinus.* *The citron-coloured Rotifer.*—Body fusiform, lower part gradually attenuated into a foot; its horn-like processes elongated, eyes round,

respiratory tube toothed. The extremities are transparent, the middle of the body of a citron colour; it often exhibits longitudinal folds, and is then less transparent. Found amongst oscillatoria. Length 1-24th.

693. Rotifer (?) *erythraeus. The Arabian Rotifer.* —Body small, oblong, suddenly attenuated into a long foot. Length 1-240th.

694. Rotifer *macrurus* (*Vorticella macrura,* M.) *The long-footed Rotifer.*—Body transparent, ovato-oblong, suddenly attenuated into a long foot; this is distinguished from Actinurus by its small toes, horn-like processes, and suddenly-attenuated body. The style, or respiratory tube, is ciliated in a star-like manner. The wheels are prominent, and it is altogether a choice subject for the microscope. Found in boggy water. Length 1-350th.

685. Rotifer *tardus. The idle Rotifer.*—Body hyaline, fusiform, gradually attenuated to a foot, and having deep strictures in the form of square false articulations or joints; eyes oblong. It resembles internally R. vulgaris. Length 1-80th.

Genus CLXXXII. Actinurus. *The three-toed Rotatoria* are provided with two frontal eyes, and a foot, furnished with two little horn-like processes, and three toes. In other respects the organization resembles Rotifer vulgaris.

696. Actinurus *Neptunius* (*Vorticella Rotatoria,* M.) *The elongated Actinurus.*—Body white, fusiform, gradually attenuated into a long foot, having three equal toes exceeding the horn-like processes in length. The chewing action of the jaws in the œsophagal head is often distinctly seen. *Fig.* 481 represents this animalcule extended, with the

wheels withdrawn, which is the case when crawling; the respiratory tube is then seen, terminated by a single delicate hair-like point; *fig* 482 shews one contracted, but the head partially withdrawn; *fig*. 484 represents the upper part, when the wheels are extended and in action; *fig*. 483 is the œsophagus and jaws, separated and extended under the pressure. Length 1-36th to 1-18th.

Genus CLXXXIII. MONOLABIS. These *Philodinean Rotatoria* have two frontal red eyes, and a foot with two toes, but no horn-like processes. They are provided with muscles for moving the double rotatory apparatus, two for moving the foot, and four belong to the œsophagal head and jaws, which latter are furnished with double teeth, or teeth in rows. A very short œsophagal tube, and a simple conical alimentary canal, are seen in both species, one of them has two spherical biliary glands; an ovarium is seen in both, but in neither has fully-developed ova or male organs been observed. In one species a respiratory tube is present.

697. MONOLABIS *conica*. *The stout Monolabis.*—Body stout, provided with a respiratory tube, or spur, and three teeth in each jaw. Between the rotatory organs the brow can project and resemble a proboscis. *Figures* 485, 486, represent different views from the under side. Length 1-120th.

698. MONOLABIS *gracilis*. *The slender Monalabis* has a more slender body than the last, and two teeth in each jaw, but no respiratory tube or spur. Length about 1-200th.

Genus CLXXXIV. PHILODINA. *The necked Rotatoria* have two cervical eyes, and horn-like processes to the

foot. All the species possess two vibratile or wheel organs upon the breast, and five of them have a frontal ciliated proboscis. Longitudinal muscles are distinct in one species, and two for moving the foot in six. The œsophagal head has four muscles, its jaws are two-toothed in four species, three-toothed in two species, but in one species the œsophagal head has not been satisfactorily seen. The alimentary canal is filiform, with posterior enlargement in six species; in one it appears to have pouches or pockets. The glandular or cellular mass surrounding the filiform part of the canal sometimes becomes distinctly coloured when the creature eats coloured food, and therefore seems connected with the nutritive system, and is probably a convolution of cœcal appendages. Biliary glands are found in six species. The ovarium developes eggs, but very seldom living young, hence they are only occasionally viviparous; three species possess a contractile vesicle, one sexual glands. A respiratory tube at the neck is always present, in some cases it is ciliated. Transverse vessels are seen only in P. erythropthalma. Eyes are found in all the species, and nervous ganglia connected with them in P. erythropthalma; sometimes the eyes are very pale, hence a single specimen may be mistaken for Callidina.

699. PHILODINA *erythropthalma.* *The slender Philodina* is white and smooth, the eyes round, horn-like processes of the foot short, and the jaws two-toothed. This species is common, and found abundantly during the spring and summer in water tubs, and amongst conferva. In glass vessels it increases rapidly, and if supplied occasionally with two or three stems of hay the breed may

be preserved for years. It is often met with in vegetable infusions of different kinds; in these, however, it never originates, but only increases in number Length 1-120th to 1-48th.

700. PHILODINA *roseola. The rose or flesh-coloured Philodina.*—Body smooth, eyes oval, horn-like processes of the foot short. "I have observed," says Ehrenberg, "that this animalcule, when kept in glasses, deposits its eggs in heaps, and the parent remains a long time with the young ones produced from them, forming a sort of family or colony, and which we are not to be hindered from ascribing to *a sense of company or family*, though the pride of man may laugh at it." *Fig.* 490 represents one with the wheels extended. Length 1-72nd to 1-48th.

701. PHILODINA *collaris. The collar Philodina* is hyaline, or white, body smooth, eyes round, a prominent annulus or collar is round the neck. It is especially characterized by the breadth of the alimentary canal, and cœcal appendages attached to it, so that, when the animalcule is fed upon indigo, it appears like a polygastric animalcule. Length 1-120th.

702. PHILODINA *macrostyla. The long-horned Philodina* is white and smooth, with oblong eyes; it has three teeth in each jaw, and the horn-like processes of the base of the foot are long. Found amongst oscillatoria. Length 1-70th.

703. PHILODINA *citrina. The yellow Philodina.*—Body smooth, citron coloured in the middle, extremities white, eyes variable in form, horn-like processes slightly elongated. Found amongst oscillatoria. Length 1-70th.

704. PHILODINA *aculeata. The spinous Philodina.*—

Body white, provided with soft spines, eyes round. The respiratory tube is thickened anteriorly in a globose manner, the jaws have each three teeth. *Figures* 487, 488, represent this animalcule, and *fig.* 489, the jaws and teeth separate. Length 1-70th.

705. PHILODINA *megalotrocha.* *The great-wheel Philodina* is white, the body smooth and short, the wheels large, the proboscis between them long, the eyes oval, and the jaws two-toothed. Length 1-216th to 1-108th.

Family XXX.—BRACHIONAEA.

The concluding family of the Rotatoria, Brachionaea, is distinguished by its members being provided with two rotatory organs, and in possessing a lorica.

The lorica is a *testula*, and not a *scutellum*. The rotatory apparatus is often apparently composed of five parts, three central and two lateral. The latter alone constitute the rotatory organs, the others are only ciliated frontal portions, which, during the vibration of the rotatory organs, remain stiffly extended as feelers. Some (perhaps all) have two setæ at the rotatory apparatus, as in Synchaeta. The genera Noteus and Brachionus have a forked foot, Anuraea is destitute of foot, and Pterodina has a sucking disc at the end of the foot, but no toes. All the genera have jaws, with teeth, attached to an œsophagal head, having four muscles. In Pterodina the jaws are partly two-toothed and row-toothed (*zygogomphia lochogomphia*), in the other genera they are many-toothed (*polygomphia*). In Noteus and Pterodina the alimentary canal is constricted, forming stomachs (*gasterodela*); in the rest it is partly simple (*coelogastrica*), partly with stomachs. Biliary glands have been observed in all the genera, as also an ovarium, male glands, and contractile vesicle. Many species of Anuraea, Brachionus, and Noteus, carry their eggs attached to them, after expulsion. In all the genera, except Pterodina, internal tremulous gill-like organs, attached to the male glands, have been observed, and respiratory tubes exist in some species of the genera

Anuraea, Brachionus, and Noteus. A nervous system is indicated by the presence of red visual points in all, except Noteus, which, however, possesses a cerebral ganglion.

Some of the Brachionaea are so numerous, as to render the water milky and turbid.

The genera are disposed as follow:—

Eyes absent, with a furcated foot			Noteus.
Eyes present	one (cervical) eye	no foot	Anuraea.
		foot furcated	Brachionus.
	two frontal eyes, foot styliform		Pterodina.

Genus CLXXXV. Noteus. *The egg-carrying Brachionaea* are destitute of visual organs, but provided with a furcated foot (Brachioni wanting eyes). The two-wheeled vibratory organ has between its portions a three-lobed ciliated brow, but has no long feeler bristles; it possesses, (as also the furcate foot,) distinct muscles. The lorica has spines both anteriorly and posteriorly; an œsophagal head, with jaws, having many teeth (*polygomphia*), a constricted alimentary canal or stomach (*gasterodela*), with two large glands; an ovarium, two sexual glands, and a contractile vesicle, are to be recognized. There is also a trace of tremulous gills, a short and thick respiratory tube, and a large central ganglion, lying between the muscles of the vibratory organs.

706. Noteus *quadricornis.* *The four-horned Noteus* has a suborbicular lorica, depressed, rough (scabrous), and urceolated; it has anteriorly four horns, posteriorly two spines. This animalcule is large, very transparent, and of a whitish colour. *Figs.* 491 to 493 represent dorsal, ventral, and side views; and *fig.* 494 the jaws separate, and

under pressure. Found amongst decayed sedge-leaves and oscillatoria. Length 1-120th to 1-72nd.

Genus CLXXXVI. Anuraea includes Brachionaea which have a single cervical eye, but no foot (Brachioni without feet.) In seven species the lorica has facetta upon the back, in four longitudinal striæ: in three it is smooth, in thirteen species it is spinous anteriorly, and in seven posteriorly also. A. biremis has a moveable spine on each side: one species is found as an empty shell only; in the rest the rotatory organs, with their cilii, as also often their muscles, are seen, but no longitudinal ones have been observed in any of the species. Jaws and teeth are seen in nine species. A constricted alimentary canal (*gasterodela*) in four, and a simple conical one (*coelogastrica*) in nine. They have two biliary glands at the commencement of the alimentary canal; an ovarium is seen in twelve species, but sexual glands and a contractile vesicle only in one of the larger and smooth species, in which also four tremulous gill-like organs are found. In three species respiratory tubes emanate from the neck. The eye, which is always present, indicates the existence of a nervous system. In A. squamula, curvicornis, biremis, striata, and foliacea, nervous matter is seen below it. Eight species have their eggs attached to them after they are expelled. They swim freely, though not very quick.

(*a*).—*Species posteriorly devoid of spines and pedicle.*

707. Anuraea (?) *quadridentata. The four-horned Anuraea.*—Lorica oblong, with four horns anteriorly, the posterior end obtuse, back tesselated. Length 1-216th, without the horns.

708. ANURAEA *squamula* (*Brachionus squamula*, M.) *The fish-scale Anuraea* is smooth, obtusely square, with six horns in front, obtuse behind. *Figs.* 495 to 497 represent different views of this animalcule, the two latter have an egg attached. Length 1-240th.

709. ANURAEA *falculata. The sickle Anuraea* is oblong, has six teeth anteriorly, the two central ones curved outwards, like sickles. The surface of the lorica is not ridged, but rough, the posterior extremity obtuse. Length 1-144th.

710. ANURAEA *curvicornis. The crooked-horned Anuraea* is nearly square, with six frontal horns, the two middle ones being larger, and curved outwards and downwards. The dorsal surface is tesselated; its large red round eye is seated upon a large nervous ganglion; the œsophagal head has three-toothed jaws. This animalcule also carries the eggs attached. Length 1-216th.

711. ANURAEA *biremis. The two-ruddered Anuraea* is linear and elongated, with four horns anteriorly; the back very smooth, and having two lateral spines, like oars. The œsophagal head has three-toothed jaws. Found in phosphorescent sea water. Length 1-144th.

712. ANURAEA *striata* (*Brachionus striata*, M.) *The striated Anuraea* is linear and elongated, with six horns in front, the back having twelve longitudinal flutings or rays, and being obtuse at the end. This species is very changeable in form, owing to the membranous lorica yielding to the contraction of the body, hence it is sometimes long, at others short, sometimes urn-shaped, bell-shaped, and even almost disc-shaped; the first, however, seems to be the normal form. Found in fresh and salt water. Length 1-130th.

(b.)—Spinous, or attenuated in pedicle-like manner posteriorly.

713. ANURAEA *inermis.* *The unarmed Anuraea* has an oblong lorica, attenuated and truncated posteriorly; no spines anteriorly, back furnished with faint longitudinal rays. Found in peat water. Length, when extended, 1-144th.

714. ANURAEA *acuminata.* *The pointed Anuraea* has an oblong lorica, attenuated and truncated at the posterior extremity, having anteriorly six sharp-pointed horns or spines, and twelve longitudinal rays on the back. Found amongst conferva. Length about 1-120th.

715. ANURAEA *foliacea.* *The foliaceous Anuraea* has an oblong lorica, six teeth anteriorly, posterior terminating in a spinous manner, like a pedicle, the dorsal and ventral surfaces longitudinally striated, and the frontal region rough. It has four-toothed jaws, and a central ganglion below the eye. Length 1-180th.

716. ANURAEA *stipitata* (*Brachionus*). *The shovel-shaped Anuraea.*—Lorica nearly square, or triangular, the anterior having six teeth, or spines; posterior single, pointed like a pedicle, the back tesselated. *Fig.* 498 represents a dorsal view, with the wheels extended. Length about 1-200th.

717. ANURAEA *testudo.* *The tortoise Anuraea.*—Lorica square, having anteriorly six straight spines, all nearly the same length, and posteriorly a short one at each corner. The upper and under surfaces are rough, and the former tesselated like Noteus. Length about 1-200th.

718. ANURAEA *serrulata.* *The rough Anuraea* has an ovate square lorica, with six unequal spines anteriorly, the

two middle ones long and curved; it has two short spines at the posterior angles, which are sometimes scarcely apparent. The surfaces are rough, and the dorsal also tesselated, like the preceding species. Independent of the two wheels, the brow has three cylindrical ciliated processes, truncated at their extremities. Length 1-216th.

719. Anuraea *aculeata* (*Brachionus quadratus,* M.) *The spinous Anuraea* has a square lorica, with six spines anteriorly, the two middle longest; at the posterior angles are two long and equal spines; the back is rough and tesselated, the under side smooth. At the brow, between the two wheels, is a single ciliated frontal process; a little respiratory tube is situated in front of the eye. Length 1-144th; including the spines, 1-96th.

720. Anuraea *valga*. *The hobbling Anuraea.*—Lorica nearly square, with six spines anteriorly, the two middle ones longest; at the two posterior angles is a spine of unequal length; the dorsal and ventral surfaces are rough, the former tesselated. The jaws are five-toothed, the red eye oval, its longer axis being tranverse. Length, without the spines, 1-210th.

Genus CLXXXVII. Brachionus. *Brachionaea* which have a single cervical eye and a furcated foot. In all the species the lorica is a closed shell, with two openings like a tortoise-shell (*testula*), the margin of whose anterior opening is toothed, as also, sometimes, that of the posterior. In B. bakeri and militaris, the lorica is rough, and in the former tesselated; in all the other species it is smooth; within its lorica the animalcule can completely withdraw itself. The locomotive organs consist of a double rotatory apparatus and a wrinkled and very flexible furcated foot.

Between the rotatory organs are from one to three frontal processes, which are provided with long cilii, or feeler-like hairs; between these processes, in six species, are from two to four long styles or bristles. The rotatory organs, when not completely extended, sometimes appear as if two or three-lobed. In all the species, from two to eight internal muscles, for ·moving the vibratory organs, are observed; also two foot muscles; and in six species from two to eight internal longitudinal ones. The digestive system comprises a large muscular œsophagal head, with two many-toothed jaws (mostly five, in B. polyacanthus four toothed); a short œsophagus, and a constricted alimentary canal (*gasterodela*); except in B. militaris, which is simple and conical (*coelogastrica*); two biliary glands, variously modified in form, are present in all. Seven species are hermaphrodite, male glands, a contractile vesicle, and an ovarium being seen; in the others, their roughness precludes their being satisfactorily perceived. No species is viviparous. All of them carry their eggs attached, often as many as eight or ten at a time. B. pala allows the eggs of another creature to be attached to its back, which it carries about until the young creep out. Traces of a vascular system are indicated in all by the presence of a respiratory tube in the neck; in B. pala are transverse vessels, and in four species, from six to eight tremulous gill-like organs are attached to the sexual glands. Of the nervous system, the chief ganglion, that beneath the red eye, is distinct in all. In four, the pigment of the eye is inclosed in a sharply four-cornered cell, as in Cyclops, and appears to be two cells connected together laterally. In the cell, the pigment is variously distributed,

so that, in a physiological sense, there is no lens or cornea. B. pala, urceolaris, and rubens, sometimes increase in such quantities as to render the water milky and turbid. Several species are infested with Vorticellae, Epistylis, and other parasites, which attach themselves to their shells.

721. Brachionus *pala.* *The four-horned Brachionus* has a smooth lorica, with four teeth or spines in front, and two obtuse ones near the opening for the foot. This creature swims in a perpendicular position, the brow being directed upwards. Each jaw has five teeth; the alimentary canal, being restricted, forms a stomach. Length 1-36th; lorica only 1-48th.

722. Brachionus *amphiceros.* *The double four-toothed Brachionus* has a smooth lorica, with four spines, both in front, and posteriorly. This species may be distinguished from the preceding by its size, want of frontal setæ, and by the four sharp posterior teeth. Length 1-72nd.

723. Brachionus *urceolaris* (*Brachionus urceolaris,* M.) *The urn-shaped Brachionus* is whitish, has a smooth lorica, six very short spines in front, the posterior extremities rounded. The points of the lorica are shorter and less sharp than in the following species; its lorica is slighty granulated; delicate longitudinal ridges proceed from the spines; the jaws have each five teeth. Both sexual glands and contractile vesicle, as well as an ovarium, are seen. Found in fresh and brackish water. Length 1-96th to 1-72nd.

724. Brachionus *rubens* (*Brachionus urceolaris,* M.) *The reddish Brachionus* has a smooth lorica, with six sharp spines in front, and posterior rounded; the body is red. Length 1-50th.

725. Brachionus *Mülleri.* *Müller's Brachionus* has a smooth lorica, with six obtuse spines in front, and terminated by two short ones, resembling papillae. This species is somewhat larger than B. urceolaris, and has peculiarly-shaped frontal spines. The margin of the chin (brow) is smoothly truncated, having three faint indentations. The lorica is very transparent. Length 1-60th.

726. Brachionus *brevispinus.* *The short-spined Brachionus* has a smooth lorica, having six acute unequal spines in front, and four stout spines posteriorly, the two inner ones short; two sexual glands and a contractile vesicle are present. Found in slow running clear water, with conferva. Length 1-65th.

727. Brachionus *Bakeri* (M.) *Baker's Brachionus* has a rough lorica, the middle of which is tesselated on its dorsal surface; six unequal acute teeth anteriorly, two elongated (lateral and dorsal) spines posterior, and short ones at the sheath of the foot. The lorica is covered with delicate granules; those upon the middle of the ventral surface are arranged in parallel but somewhat curved lines. Length 1-120th to 1-60th.

728. Brachionus *polyacanthus* (M.) *The many-spined Brachionus* has a smooth lorica, having anteriorly four long dorsal teeth or spines, six short ones at the margin of the chin (ventral), and, posteriorly, five dorsal spines, the two external, or lateral ones, very long. *Figures* 499 to 501 represent dorsal, side, and under views of this animalcule; the former having the wheels extended, and the side view shewing the respiratory tube and an ovum attached. Length, without spines, 1-110th.

729. Brachionus *militaris.* *The armed Brachionus*

has a rough (scabrous) lorica, with twelve long and nearly equal spines anteriorly, and four posterior ones; the two middle ones unequal, and shorter than those of the preceding species. Length, without spines, 1-120th.

Genus CLXXXVIII. PTERODINA. *The winged Rotatoria* include Brachionaea which have two frontal eyes and a simple styliform foot. All the species have a smooth, flat, and soft lorica, like a tortoise-shell (*testula*); they are curved at the margin. A double rotatory apparatus, and a simple conical foot, having a suction disc at the end, and sometimes cilii, are common to all. P. elliptica alone has a hairy frontal process between the wheels. Transverse or longitudinal muscles exist in all the species. The four-muscled œsophagal head has jaws, with teeth in rows in two species (*locogomphia*), and double-toothed (*zygogomphia*) in P. elliptica; the alimentary canal is constricted (*gasterodela*), and possesses, anteriorly, two glands; an ovarium is also seen in all the species. Sexual glands and a contractile vesicle are present in P. patina. No evidences of a vascular system have been discovered, and two red frontal points (probably eyes) are the only indications of a system of sensation.

730. PTERODINA *patina* (*Brachionus patina*, M.) *The dish-like Pterodina* has a membranaceous lorica, orbicular and crystalline, slightly scabrous near the broad margin, and excised anteriorly between the wheels. This species is very delicate and transparent. *Fig.* 502 represents a side view of this animalcule, and *figures* 503 and 504 under views; the latter having the wheels extended, the former having them withdrawn, and the anterior margin bent in, so that the eyes appear near the middle of the lorica. Found,

in summer, among lemna and Ceratophyllum. Length about 1-120th.

731. PTERODINA *elliptica.* *The elliptical Pterodina* has a membranaceous elliptical lorica, with a narrow, smooth margin, the front entire (not excised). The two wheels are united by a brow furnished with setæ. The eyes are distant. Found amongst conferva. Length 1-120th to 1-108th.

732. PTERODINA *clypeata* (*Brachionus clypeatus,* M.) *The shield-like Pterodina* has a membranaceous oblong lorica, narrow, and smooth at the margin; it has a frontal portion, or brow, connecting the two wheels, but destitute of setæ. The eyes are approximate. *Fig.* 505 is a dorsal view, with the wheels extended. Found in sea water. Length 1-120th; the shell, 1-144th.

APPENDIX.

AN ABSTRACT FROM THE LATE WORK OF DR. EHRENBERG ON THE INFUSORIA BELONGING TO THE CHALK FORMATIONS.

THE author states in 1837 he communicated to the Berlin Academy the discovery of Synedra ulna, &c. in the polishing slate (Poler Schiefer) of Oran; and in December, 1838, that five or six species of Infusoria existed in some of the chalk formations, which were so similar to existing species that they afforded no tangible marks of difference, and, therefore, did not authorize the adoption of new names. Since then he has prosecuted the investigation, the result of which is given hereinafter.

In the introduction Dr. E. states that one of the most remarkable facts elicited in the course of his examination of the sea water, whilst in a state of phosphorescence, was, the presence of several species of two genera, the members of which have siliceous loricæ, which are abundant, not only in the chalk marls of Caltanisetta, Sicily, Oran, Zante, and Greece, but are those forms which, from the incalculable number of their very minute loricae, compose the chief portion of the marls which depend for their origin on the remains of species of Infusoria; and further, that they belong to genera, species of which had not then been seen in the living state. Subsequently the greater number were taken in a live condition to Berlin, by Dr. Ehrenberg, who has come to the conclusion that, from amongst these, Actinocyclus senarius, Coscinodiscus patina, and Gallio-

nella sulcata, may be shewn as the chief forms met with in examining the chalk marls of Sicily, and also that the species of the chalk formations are yet to be found as crowds of living creatures in the waters of our seas.

(*a*). *Climatorial Relationships.*—Europe, Africa, Asia, America, and the Isle of Bourbon, exhibit the same creatures, partly in a fossil condition, and partly alive, in various relationships, as has been already shewn, but which knowledge has lately been most materially extended, as also that concerning the general distribution of the same species, both in fresh water and the sea. So general, in fact, is such distribution, that the forms of the Siberian Alps, the Altai Mountains (high lands of upper Asia), and those of the waters near Berlin, and of the Nile, at Dongola, are so similar, that, to a certain extent, when brought together and compared, no differences, agreeing with the principles of natural history, could be discerned.

(*b*.) *Self-division.*—The importance of this power, so forcibly exhibited in the various tribes of animalcules, is well shewn by the fact that a creature, invisible to the naked eye, can, in the space of four days, give origin to no less than 140 billions of beings; and as, from the size, &c. of the bodies, we can easily calculate that 40,000 millions of individuals exist in a cubic inch of the polishing slate of Bilin, so 70 billions must be necessary to form a cubic foot of the same structure.

Genus Amphitetras belongs to the family Bacillaria, and must be ranged under section Naviculaceae. Its members are characterized by being unattached, and having a simple bi- or multi-valved siliceous lorica, which is square, and has four openings, situated at the angles of its opposed lateral faces. The self-division is imperfect, but the chain-like masses which the individuals form are not gaping, like some other genera.

733. Amphitetras *antediluviana.*—Each shell-like

lorica is of a cubical form and cellulose, the lateral surfaces being radiated, the angles assuming various conditions. In this creature the angles of the lorica are sometimes very obtuse, and the sides of it straight; in others they are elongated, in the form of little horns, and the sides very much sloped out. The lateral surfaces are very similar to the head-piece of a Bothriocephalus. Found living in the waters of the Cattegat, and in a fossil state in the chalk marl of Oran and Greece. Diameter 1-860th to 1-430th.

A few days before Dr. Ehrenberg sent part of his work to the press, he discovered a second species of this genus in the chalk marl of Greece, which he states should be named (734) *A. parallela*, as the lateral surfaces of the lorica are marked by parallel rows of cells.

Genus CERATONEÏS belongs to the tribe Bacillaria, section Naviculaceae. Its members are free, and possess a simple prismatic bivalved siliceous lorica, with two central opposed openings, whose solid edge is bounded by two diverging longitudinal furrows, which appear to pass through the horns of the lorica. In consequence of self-division being complete, no chain-like masses are formed by the members of this family, though they may be found in pairs, or solitary.

735. CERATONEÏS *closterium*.—Setaceous and lunate in form, having two very long horns, twice the length of the body. The form of this creature is like that of Closterium setaceum. The ova are of a brownish-green colour, but the long delicate horns are colourless. The lorica is smooth, and the motion is easily seen, as it is very lively. Found abundantly, along with Closterium setaceum, in the sea near Cuxhaven and Wismar. Length 1-290th to 1-220th; body, without the horns, 1-1150th.

736. CERATONEIS *fasciola*.—Linear, lanceolate, and shaped like the letter S, the horns being shorter than the

body, and curved in opposite directions. The body, without horns, is like Navicula gracilis. Sexual glands, as also locomotion, are visible. Found alive in sea water, near Cuxhaven. Length 1-430th.

Genus Dinophysis belongs to the family Peridinaea, its members being characterized by having a membranaceous lorica, with a transverse ciliated furrow, and furnished with a plaited crest. No visual organs are apparent, and the animalcules are free. This genus was considered at first to belong to the family Ophrydina.

737. Dinophysis *acuta*.—Lorica ovate, urceolate and granulated, the frontal portion as if operculate, plane; the posterior sub-acute. Within the body brown vesicles were seen; these are considered as stomachs filled with food, the transparent colourless ones as empty digestive sacs. This species lives along with the phosphorescent Peridinaea, and exceeds them in the quickness of its motion. Living, in sea water, at Kiel. Diameter 1-580th.

738. Dinophysis *Michaelis*.—Lorica ovate, urceolate and granulated; the frontal portion as if operculate, plane, and very broad; the posterior rounded. This species is very similar to the preceding, being only distinguished by its broad front and rounded back. Found alive, in sea water, at Kiel. Length 1-580th.

Genus Eucampia belongs to the family Bacillaria, section Desmidiaceae. The lorica is univalved, wedge-shaped, and flat, excised in the middle of its lateral surfaces. The self-division being imperfect, the creatures are clustered in the form of plane articulated chains, having roundish holes (*lacunosas*) in them; the chains being curved gradually become circular; cluster unattached.

739. Eucampia *Zodiacus*.—Lorica crystalline, smooth, a little longer than it is broad; ova of a light yellow colour. Locomotion not perceptible. Found alive, in sea water, at Cuxhaven. Diameter 1-1150th.

Genus GRAMMATOPHORA belongs to the Bacillaria, section Naviculaceae. The members have a simple bivalved prismatic siliceous lorica, and are unattached. Self-division is imperfect, and the cluster curved, the joints gaping at one of the angles. Within are generally seen two undulated folds, dividing the body into three longitudinal portions.

740. GRAMMATOPHORA *Africana*.—Wands, when viewed dorsally, square or oblong; from the side, Navicula-like (boat-shaped), and obtuse. Internal folds three, and undulated. Found, fossil, in the chalk marl of Oran, and alive, in sea water, at Tjörn. The live creature has brownish, or golden-yellow-coloured ova, filling the whole of the interior, and only leaving a bright transverse band empty just where the transverse tube goes through the body. Length 1-2300th to 1-480th.

741. GRAMMATOPHORA *angulosa*. — Wands, when viewed dorsally, square or oblong; from the side, Navicula-like, and obtuse; internal fold having many acute angles. It is not very certain whether this species is only a variety of the preceding. Found fossil in the chalk marl of Oran, and alive, in sea water, at Tjörn. The creature is colourless. Length of fossil 1-910th; the living, 1-1150th.

742. GRAMMATOPHORA *Mexicana*. — Wands, when viewed dorsally, quadrangular; from the side, linear, obtuse, the ends being suddenly constricted. Internal folds straight in the middle, uncinate at the extremity. Found alive, in sea water, at Vera Cruz. Length 1-960th, and little more than twice its breadth.

743. GRAMMATOPHORA *oceanica*.—Wands, viewed dorsally, quadrangular; from the side, navicular, or linear, obtuse, but the ends gradually attenuated; internal folds straight in the middle, uncinate towards the ends. Found fossil in the chalk marl of Oran, alive in the waters of the

Cattegat, &c. This creature forms long zigzag bands, which are fixed by mucus to algae and sertulariae. Dr. Ehrenberg saw wands which were fourteen times longer than they were broad, and some which were nearly square. The ova appear yellow or reddish-brown. Length of fossil 1-720th; living, 1-2300th to 1-360th.

744. Grammatophora *unduluta*.—Wands, when viewed dorsally, quadrangular; from the side, linear, and several times undulated; internal folds undulated. Found fossil in the chalk marl of Greece, alive in sea water at Vera Cruz. The live creatures are colourless. Greatest length from two to three times its breadth; the former 1-860th.

Genus Lithodesmium belongs to the Bacillaria, section Desmidiaceae. The lorica is simple, univalved, siliceous, and triangular in shape. Self-division imperfect, the creatures being clustered in the form of straight and rigid triangular-shaped wands; cluster unattached.

745. Lithodesmium *undulatum*.—Corpuscles large, smooth, and pellucid; the angles obtuse. Two of the sides are undulated, the others doubly excised; openings and motion are not perceptible. The corpuscles are somewhat longer than they are broad. Found alive, in sea water, at Cuxhaven. Greatest length of corpuscle, 1-480th.

Genus Podosira belongs to the Bacillaria, section Echinaceae. Its members are fixed, the lorica being pedicellate, bivalved, sub-rotund in form, and siliceous. Self-division imperfect, and giving rise to moniliform chains.

746. Podosira *nummuloides*. — Corpuscles globose, slightly compressed laterally (*discretis*); body minutely punctated. The pedicle is shorter than the diameter of the body. The largest chains contained seven corpuscles. The pedicle is colourless, the corpuscles green. Found alive on a Polysiphonia in Peru. Size of corpuscle 1-860th.

Genus Triceratium belongs to the Bacillaria, section Naviculaceae. The members are free, and have a bivalved

triangular siliceous lorica, tridentate, or corniculate, at each lateral surface. They are multiplied under the external covering by longitudinal self-division.

747. TRICERATIUM *favus*.—Shell-like lorica triquetrous laterally, plane or slightly convex, having the angles obtuse; the surface is marked with large hexagonal cells, but on the back is a smooth central zone. Found fossil in the chalk marl of Greece, and alive, in sea water, at Cuxhaven. Diameter 1-240th.

748. TRICERATIUM *striolatum*.—Shell-like lorica triquetrous laterally, convex, the angles being subacute; surface minutely punctated, back with a smooth central zone. Found living, in sea water, at Cuxhaven. Size 1-290th.

Genus TRIPODISCUS belongs to the Bacillaria, section Naviculaceae. Its members are free, and possess a round bivalved siliceous lorica, having three appendiculated processes, and dividing by longitudinal self-division.

749. TRIPODISCUS *Germanicus* (*Argus*.)—Lorica large, orbicular, and compressed, with the valves slightly convex; the margin of the cells, which are disposed in radiating series, being sometimes roughly punctated at intervals; the lateral processes are short and hyaline. Colour green. Found alive, in sea water, at Cuxhaven. Diameter 1-220th.

Genus ZYGOCEROS belongs to the Bacillaria, section Naviculaceae. Its members are characterized by being free, and having a compressed, Navicula-shaped, bivalved lorica, each end provided with two perforated horns. Self-division longitudinal and complete.

750. ZYGOCEROS *rhombus*.—Large, lorica turgid; viewed laterally rhomboidal, and having rounded angles; surface marked with very delicate striæ, the back having a smooth central zone. Found alive, in sea water, at Cuxhaven. In the 1-96th of a line there are 24-26 striæ. Diameter 1-290th.

751. ZYGOCEROS *surirella*.—Small, lorica compressed;

viewed from the lateral surface lanceolate, with the extremities constricted and obtuse, surface marked with large and distinct granular lines, becoming obliterated in the middle of the body. Found living, in sea water, at Cuxhaven. Size 1-720th; striæ to 1-96th of a line.

752. ACHNANTHES *pachypus*.—Wands striated, twice as broad as long, or ovate, each slightly bent in the middle; back and apex rounded; pedicle thick and short. Breadth of wand 1-1730th. This species was discovered by Dr. Montague, upon some conferva obtained at Callao (Peru), which he named Confervæ allantoides. Young specimens of Achnanthes subsessilis are very similar to the present species, which has seldom more than three, never more than four joints; Dr. Montague gives only two.

753. ACTINOCYCLUS *biternarius*.—Partitions not present, disc having six minutely punctated rays. This species is found in the fossil condition in the chalk marl of Oran and Caltanisetta, in Sicily, and alive, in sea water, near the island of Tjörn. The fossil state is that in which it was first discovered, and it created considerable surprise when it was found soon after in the ooze of the sea. Locomotion, or organs for affecting it, have not been seen. From A. senarius it is distinguished by the absence of the internal partitions. Diameter 1-1000th to 1-580th.

754. ACTINOCYCLUS *senarius*. (1838.)—Found fossil, very abundantly, in the chalk marl of Oran, Caltanisetta, and Greece; alive at Cuxhaven, Christiana, and Tjörn. Diameter 1-1150th to 1-430th.

755. ACTINOCYCLUS *septennarius*.—Partitions absent, disc having seven finely punctated rays. Found fossil in the chalk marl of Oran, Caltanisetta, and Zante; living, in the Cattegat. Diameter 1-1060th to 1-430th.

756. ACTINOCYCLUS *octonarius*.—Found fossil in the chalk marl of Caltanisetta and Oran; living, in the Cattegat.

757. ACTINOCYCLUS *nonarius*.—Partitions not present, disc having nine finely punctated rays. This species is found, both fossil and alive, in the same situation. The single discs of the fossil forms are generally without margin: they are sometimes quite perfect, but often in broken pieces. In the living creatures, the ova are yellow; locomotion not observable. Diameter 1-720th to 1-650th.

758. ACTINOCYCLUS *denarius*. (1838.)—Found fossil in the chalk marl of Oran; and living, in the waters of the Cattegat.

759. ACTINOCYCLUS *undenarius*.—Partitions not present, disc having eleven finely punctated rays. This species is found, both alive and in the fossil state, where the preceding one is seen. The discs of the fossil forms are destitute of margin, and are single, whilst those of the live creatures have a broad edge and are double. In those specimens in which the margin is absent there exists as many round openings as there are punctated rays. The mass of ova is divided into several portions. Diameter of the discs 1-560th to 1-480th.

760. ACTINOCYCLUS *bisenarius*.—Partitions not present, disc having twelve finely punctated rays. Found fossil in the chalk marl of Oran, and alive in the water of the Cattegat. The twelve rayed discs of the fossil forms are sometimes smaller than those of the living, but, in most cases, about equal. In the live condition, the ova are visible, as twenty-two greenish masses placed around the colourless spot in the centre of the body. Neither marginal openings or locomotion have been satisfactorily seen. Diameter of the fossil, as low as 1-860th; of the living, as high as 1-580th.

761. ACTINOCYCLUS *duodenarius*.—Disc divided internally, by partitions, into twelve cells, and having twelve finely punctated rays; six dark and six bright triangular

divisions are seen, in each of whose centre runs a narrow line, terminating at the margin in a little opening. The internal partitions appear to lie between every two of these narrow lines, so that as many as twenty-four rays may be counted, but there are only twelve openings to be seen. Diameter 1-560th to 1-480th.

762. Actinocyclus *quindenarius*.—Partitions not present, disc having fifteen finely punctated rays. Found fossil in the chalk marl of Oran, and alive in the waters of the Cattegat. The discs of this species are more arched than those of any other of the preceding ones. The fifteen rays terminate in fifteen marginal openings. The ova are distributed into forty-eight round, yellowish-brown-coloured masses, placed around the bright central spot of the body, or else appear united as one ball. Locomotion was not perceptible. Diameter of fossil forms, 1-560th; of the living, 1-560th to 1-480th.

763. Actinocyclus *sedenarius*.—Disc divided, by internal partitions, into sixteen cells, and having sixteen finely punctated rays. The ova, which are of a green colour, form, in some, separate concentric masses; in others, a single ball-like mass, placed in the middle of the body. Locomotion not perceptible. Found alive near Cuxhaven. Diameter of the shells 1-290th.

764. Actinocyclus *octodenarius*.—Disc divided by internal partitions into eighteen cells, and having eighteen finely punctated rays. This species is very similar to the preceding, being only a little larger, and having eighteen alternately dark and bright divisions, as many internal septæ, and marginal openings. The ova, in one specimen, consisted of seven large yellowish green masses, placed concentrically around the bright central spot of the body, but which did not appear to be strictly confined to the divisions or cells, which, most probably, arises from some optical deception. It was remarkable that, in this

specimen, the openings were situated at the margin, in the centre of each division. The play of colours of these divisions depends upon some optical phenomena yet to be developed. In the centre of the disc of those species provided with these divisions is a broad, bright, and polished umbilicus-like spot, which is invisible in those not possessing internal partitions. This species was found in sea water, along with the preceding. Diameter 1-240th.

765. BIDDULPHIA *pulchella.*—Shell-like lorica quadrangular, compressed, and having three to five small obtuse lateral processes. Found, living, in the sea, near Cuba, &c., and fossil in the chalk marl of Greece. Diameter 1-290th.

766. COCCONEIS *oceanica.*—Shell-like lorica elliptical, sub-orbicular, the back slightly convex, externally marked by simple, curved, and concentric lines. This species is not undulated, nor transversely striated. Found, with Grammatophora oceanica, in sea water, near Callao. Length 1-1150th.

767. COSCINODISCUS *argus* (1838.)—Shell-like lorica cellulose, the cells being large at the centre, and smaller at the circumference, the order of the rays being often interrupted. This is probably only a variety of Coscinodiscus radiatus. Found fossil in the chalk marl of Caltanisetta and Oran, and living, in sea water, near Cuxhaven. The cells of the discs from Oran vary very much in size. The ova are of a greenish colour in the living forms, which are very rare. Diameter of fossil 1-860th to 1-290th; living, 1-580th.

768. COSCINODISCUS *eccentricus.* — Shell-like lorica marked by small cells, which are disposed in eccentric curved lines. It is found in the fossil state in the chalk marl of Oran, in which condition, however, it is rare; but in the live state it is met with abundantly in sea water,

near Cuxhaven and Vera Cruz. Locomotion is not yet satisfactorily observed. Diameter 1-860th to 1-430th.

769. Coscinodiscus *lineatus*.—Shell-like lorica marked by small cells, disposed in a series of parallel and transverse lines. Found fossil in the chalk marl of Caltanisetta, and in the live condition near Cuxhaven. The cells in this species form parallel lines in whatever direction they may be viewed. In large and well-preserved fossil specimens as many as twenty-five openings were seen near the circumference. Within the live forms sometimes numerous yellow vesicles are seen, as in Galliornella. Diameter of fossil 1-1150th to 1-480th; living, 1-1150th to 1-860th.

770. Coscinodiscus *minor*.—Shell-like lorica with small scattered cells, and the whole creature small in size. Found fossil in the chalk marl of Caltanisetta, Oran, and Zante; and alive in sea water, near Cuxhaven. Diameter 1-1150th.

771. Coscinodiscus *oculus-iridis*. — Shell-like lorica marked with rather large radiant cells, except near the centre and circumference, where they are smaller. Some of the larger cells at the centre form a sort of star. Found fossil in the chalk marl of Greece, and alive in sea water near Cuxhaven. This large species is curiously marked, whilst under the microscope, with coloured rings, which are apparently caused by the peculiar arrangement of the cells. There are generally from five to nine large cells at the centre. Diameter 1-240th.

772. Coscinodiscus *patena*.—The large shell-like lorica marked with moderately-sized cells, disposed in concentric circles. The cells decrease in size towards the circumference. Found fossil in the chalk marl of Zante, and alive in sea water at Cuxhaven. The young and vigorous specimens of live individuals are completely filled with yellow granules, whilst the older ones have an irregular

yellow granulated mass within them. Diameter 1-860th to 1-240th.

773. Coscinodiscus *radiatus.*—Shell-like lorica large, marked with moderately sized cells, disposed in lines, radiating from the centre; towards the margin the cells become smaller in size. Found in the fossil condition, very abundantly, in the chalk marl of Oran, and alive, in sea water, near Wismar and Cuxhaven. Diameter 1-860th to 1-240th.

774. Dictyocha *aculeata.*—Cells arranged by sixes, in the form of a ring, each cell being spiny within. Spines six in number, long, but unequal in length, and radiating from the circumference. Found fossil in the chalk marl of Oran, Caltanisetta, Zante, and Greece; alive in the waters of the Cattegat, near Tjörn. Diameter of the fossil forms 1-2304th to 1-1150th; of the living, 1-1440th to 1-1150th, without reckoning the horns.

775. Dictyocha *fibula.*—Cells arranged in fours, in a concave rhomboid, or square form, having connected spiny angles. Found fossil in the chalk marl of Oran and Caltanisetta, and alive in sea water near Christiana. Locomotion not observed. Diameter 1-1150th to 1-560th.

776. Dictyocha *pentasterias.*—Cells not present, centre solid and concave. Five siliceous rays are present, forming a sort of star. Found fossil in the chalk marl of Greece, and alive in sea water at Christiana. This species is devoid of colour, and locomotion was not seen. It resembles Arcella. Diameter 1-1150th.

777. Dictyocha *sirius.*—Cells not present, centre solid. The six siliceous rays are broad or winged at the base, but acute at the extremity. This species is not known in the fossil condition, but is found alive in sea water near Christiana. Diameter 1-1150th.

778. Dictyocha *speculum.*—Cells arranged by sixes in the form of a ring, spines six, long, but unequal in size, radiating from the circumference, cells not spiny within. Found fossil in the chalk marl of Caltanisetta, Oran, and

Greece, and alive at Kiel and Cuxhaven. In the living forms the cells were filled with a soft greenish matter, in which vesicles and very minute granules were seen. Locomotion was perceptible after long observation. Diameter 1-860th.

218. GALLIONELLA *sulcata.*—Found fossil in the chalk marl of Caltanisetta, Oran, Zante, and Greece; and living, in sea water, at Cuxhaven.

779. HALLIOMMA (?) *radians.*—External joints not separating, shape globose, sub-ovate; the siliceous lorica having holes in it, and on all sides cells radiating from the obscure central nucleus. Found fossil in the chalk marl of Greece, and alive in sea water at Cuxhaven. Locomotion not observable; creature crystalline. Diameter 1-560th.

780. NAVICULA *didymus.*—Shell-like lorica striated; viewed from the side linear, truncated at both ends, and whole; viewed dorsally, constricted in the middle; both ends sub-orbicular, thus appearing as if formed of two discs joined together. In 1-100th of a line there are twenty-three striæ. Found fossil in the chalk marl of Caltanisetta, and living, in sea water, at Cuxhaven, Wismar, &c. This species was first observed in the live condition, afterwards fossil, in Sicily. Similar forms are very numerous in the chalk marl of Greece. It is distinguished from the two following (N. entomon and N. gemma) by the want of the constriction when viewed on the lateral surface; on the ventral surface two green ova plates are seen, divided by a broad central colourless stripe. Length 1-1150th to 1-480th.

781. NAVICULA *entomon.*—Shell-like lorica striated when viewed from either surface, constricted in the centre, striæ very broad. Found fossil in the chalk marl of Greece, and alive, in sea water, at Christiana. In the 1-100th of a line are eighteen striæ; the two halves of this species appear more of a long figure than a round one. Length of the fossil forms 1-432nd; of the living, 1-290th.

782. NAVICULA *folium.*—Shell-like lorica ovate, turgid and obtuse, slightly compressed, central aperture not present, striæ narrow, twenty-four being in the 1-96th of a line. Length 1-540th.

783. NAVICULA *gemma.*—Shell-like lorica ovato-oblong, large, turgid; central aperture not present; striæ slender, sixteen being in the 1-96th of a line. Found alive at the mouth of the Elbe. Length 1-290th to 1-220th.

784. NAVICULA *Norwegia.*—Shell-like lorica, viewed laterally, linear, narrow and truncated at both ends; from the back, broadly ovate, and acute at the extremities; circumference with a narrowly striated margin, area smooth. The 1-96th of a line contains thirty striæ. The N. praetexta of the Greek chalk marl is very similar to this species. Found alive, in sea water, at Christiana. Length 1-360th.

785. NAVICULA *quadrifasciata.*—Shell-like lorica, viewed laterally, narrow, linear, and truncated from the back, broad and acute at both ends; margin broad. "The central furrows of the mouth and dorsal surface divides the central striated longitudinal bands into two portions, from which, along with the two lateral bands, four striated bands appear, the two central ones being interrupted by the mouth." In the 1-96th of a line there are twenty striæ. Found fossil in the chalk marl of Greece, and alive in sea water at Christiana; ova greenish, or rusty yellow, in the live creatures. Length 1-430th.

786. PERIDINIUM *pyrophorum.*—Found fossil in chalk flints at Gravesend. Length 1-560th.

On the Locomotive Organs in some Naviculæ.

In the small pools left by the ebb of the tide near Cuxhaven, Dr. Ehrenberg remarked numerous little bodies, apparently similar to Navicula, Surinella elegans, and S. striatula, but which, from their comparatively very great size and structure of lorica, were easily distinguishable from the

latter, upon closer examination. One of these ribbed oval glass-like creatures, which belonged to the genus Navicula, was, besides its size, remarkable for its great mobility, and Dr. E. was enabled to investigate its system of locomotion much more satisfactorily than he had hitherto done in any of the genus. This organ he states was very different, both in form and size, to what he had before noticed in that genus. Instead of a snail-like expanding foot, long delicate threads projected where the ribs or transverse marks of the shell join the lateral portion of the ribless lorica, and which the creature voluntarily drew in or extended. An animalcule 1-18th of a line long had twenty-four for every two plates, or ninety-six in the total; and anteriorly, at its broad frontal portion, four were visible. The openings for the purposes of nutrition appeared to be at the extremity. Whether these organs were supernumerary, and existed along with cirri, &c., and the flat snail-like foot, which the rest of the Navicula possess, could not be determined. Longitudinal clefts at the broad side of the shell were not present, but as many as ninety-six lateral openings for the exit of the cirri were perfectly distinct. It is probable this creature may form the type of a special group of the Bacillaria. Of one thing Dr. E. is convinced, that the Naviculae in general are very differently constituted individually; thus, in some cases, the six round openings in the little shell are distinctly visible, whilst in others clefts, which in some cases gape, and are unprovided with circular openings, are all that can be made out.

AN INDEX

OF

THE FAMILIES AND GENERA OF INFUSORIA.

J. DARKIN, 3, CLOUDESLEY STREET, ISLINGTON.

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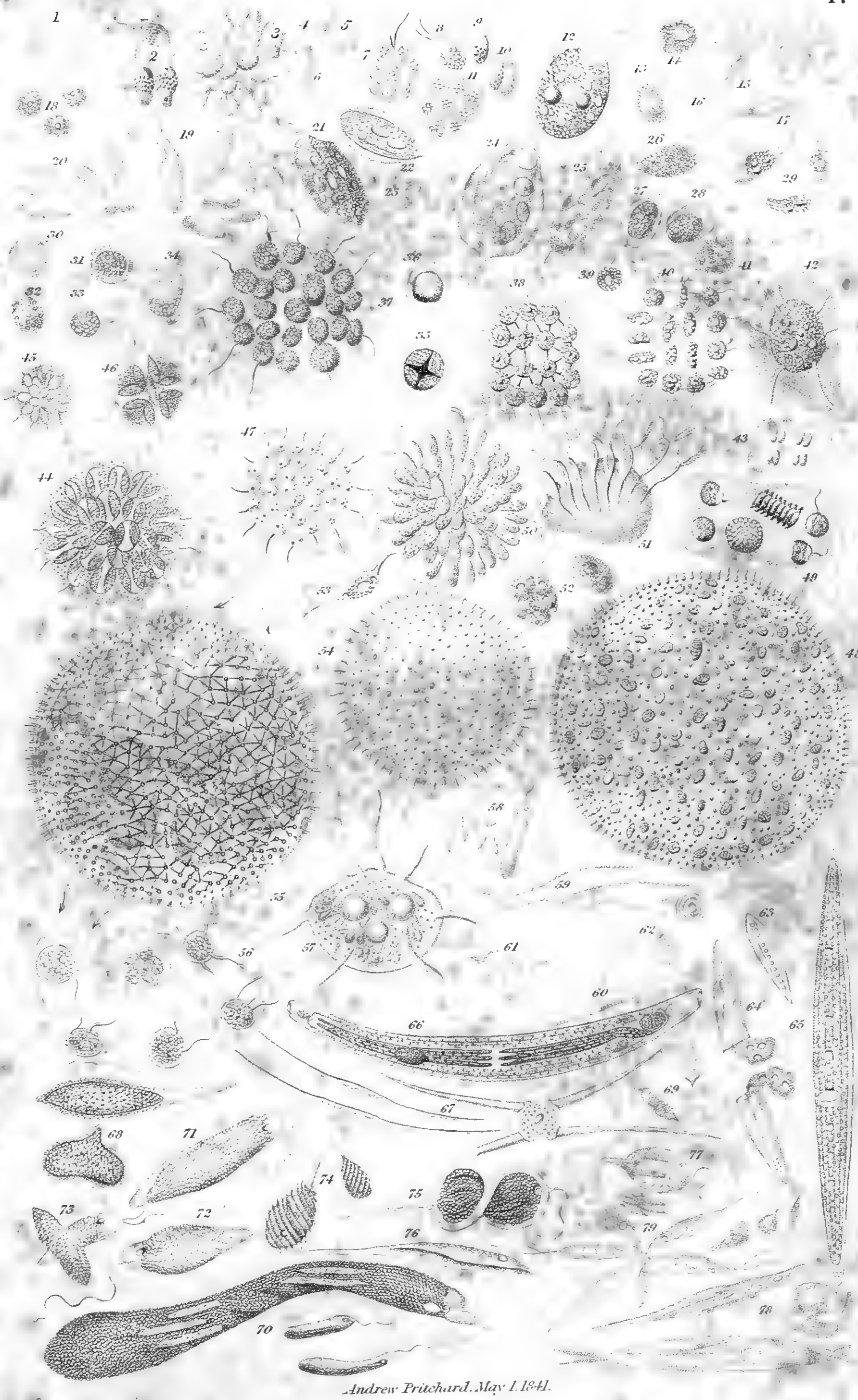

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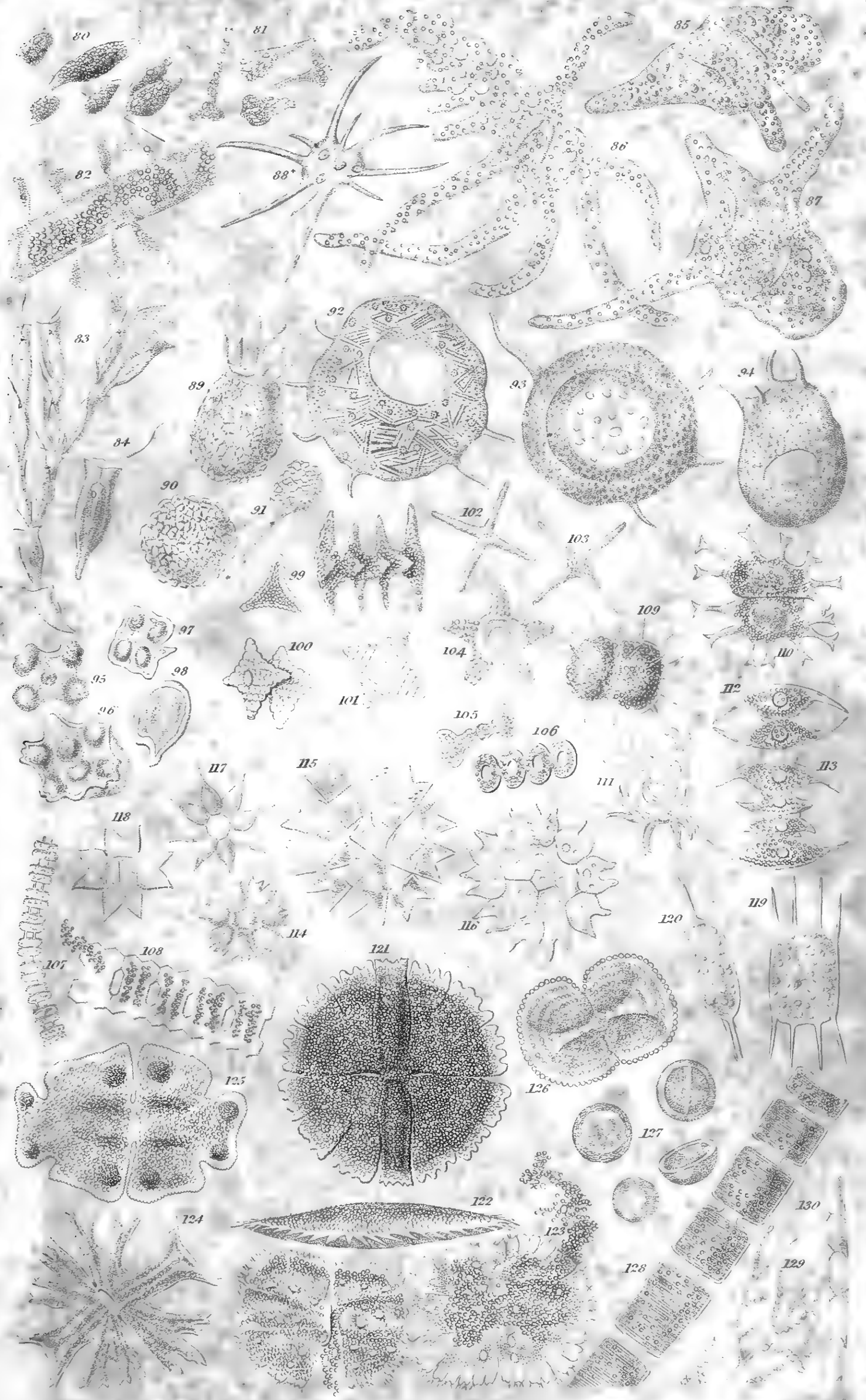

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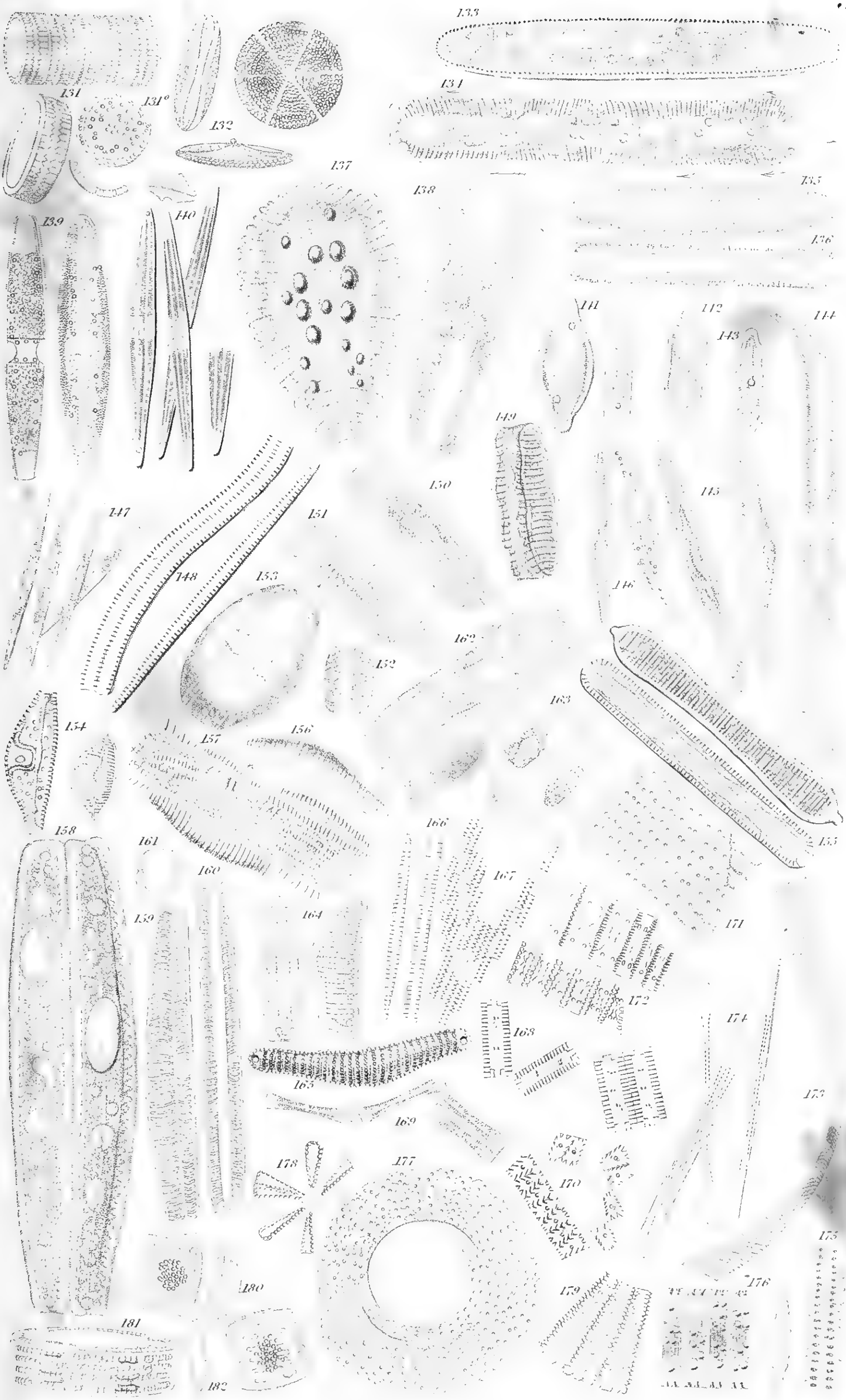

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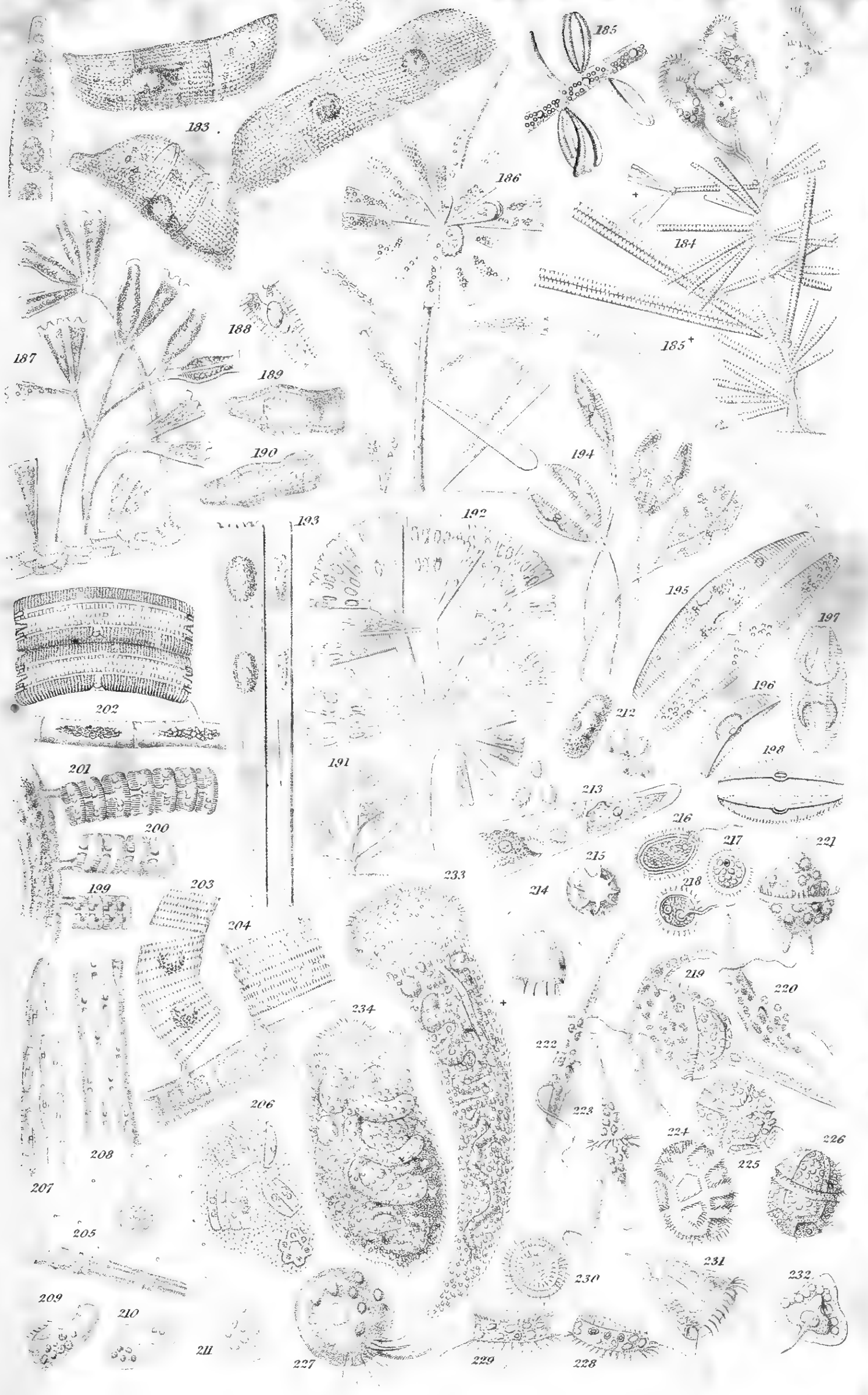

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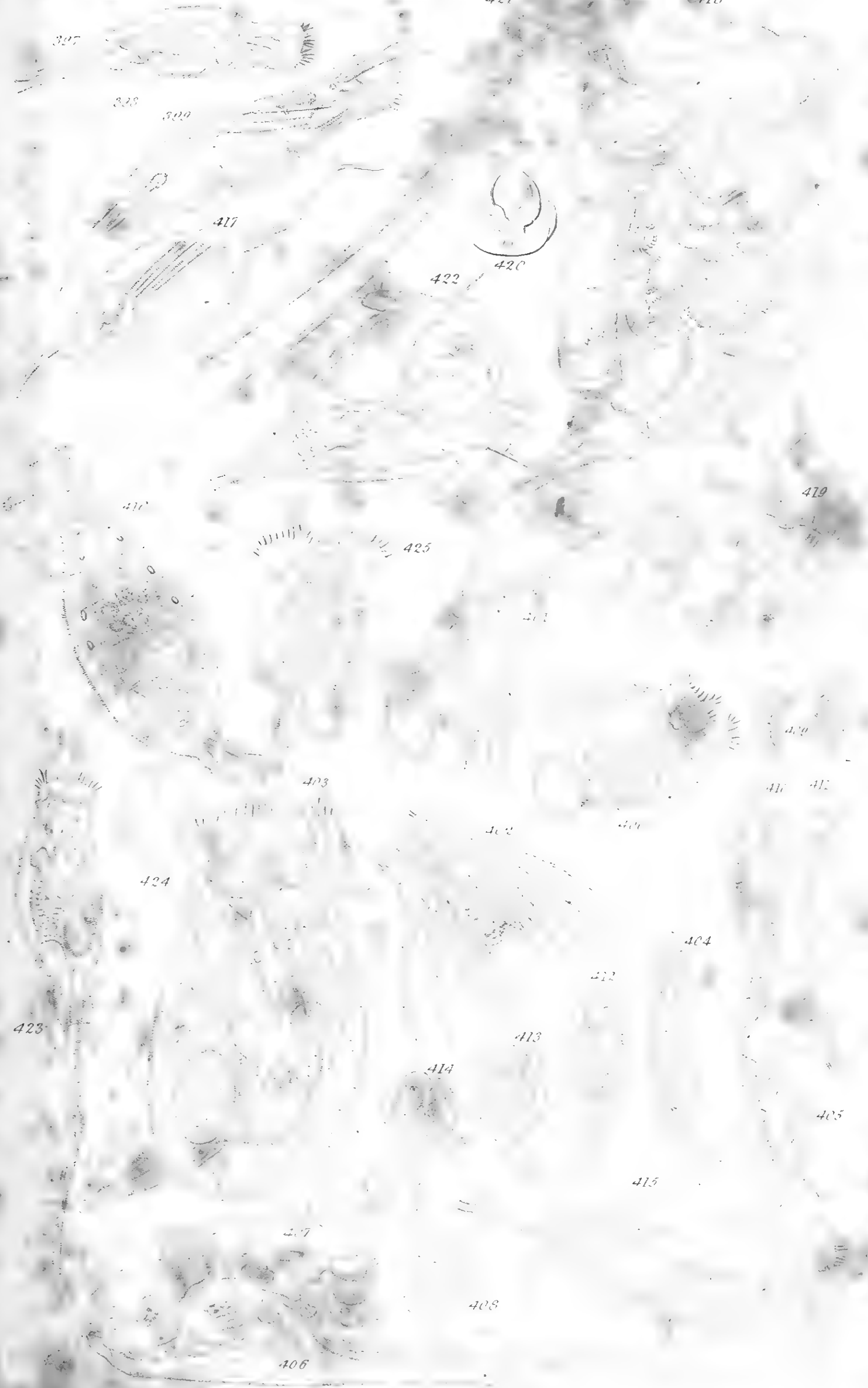

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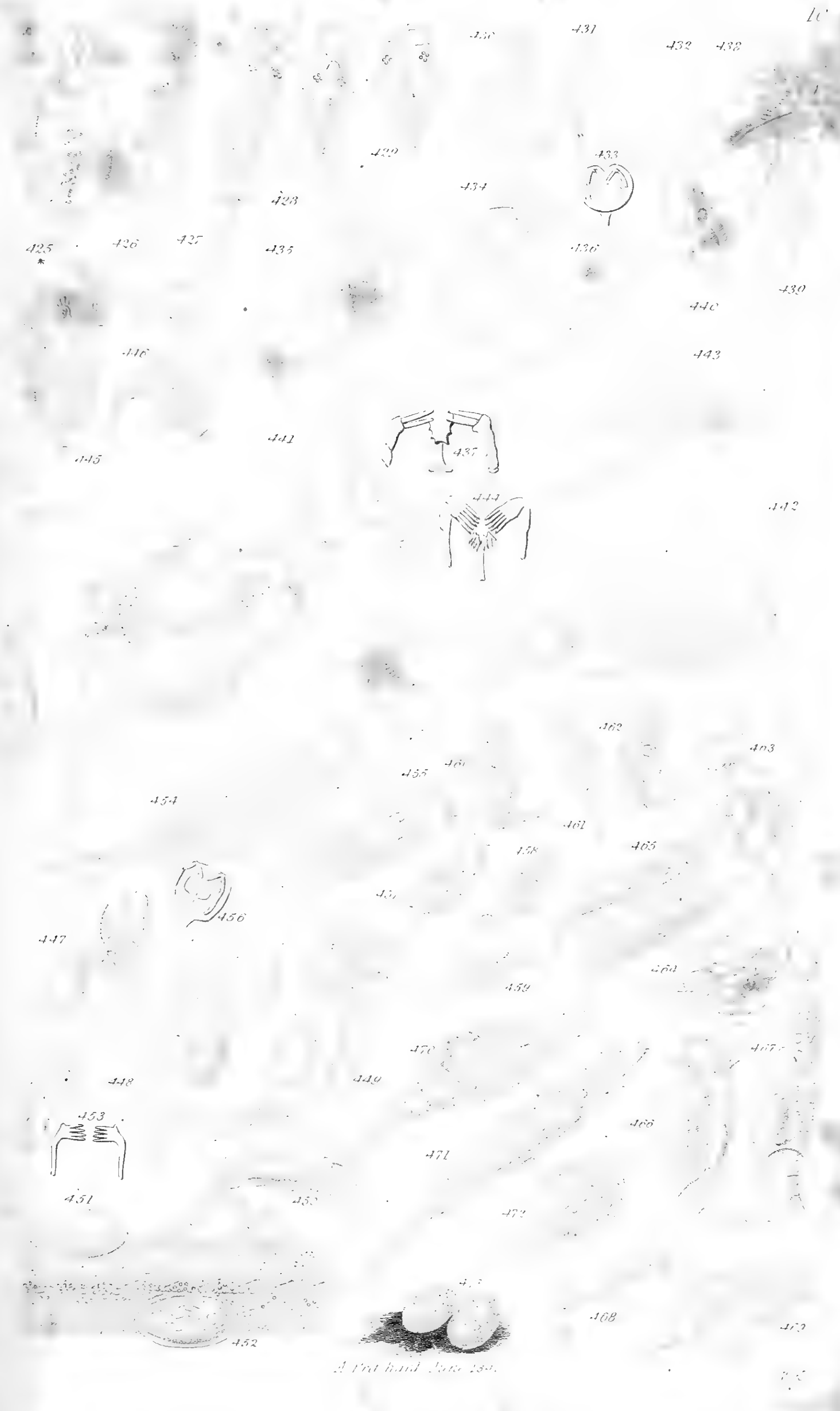

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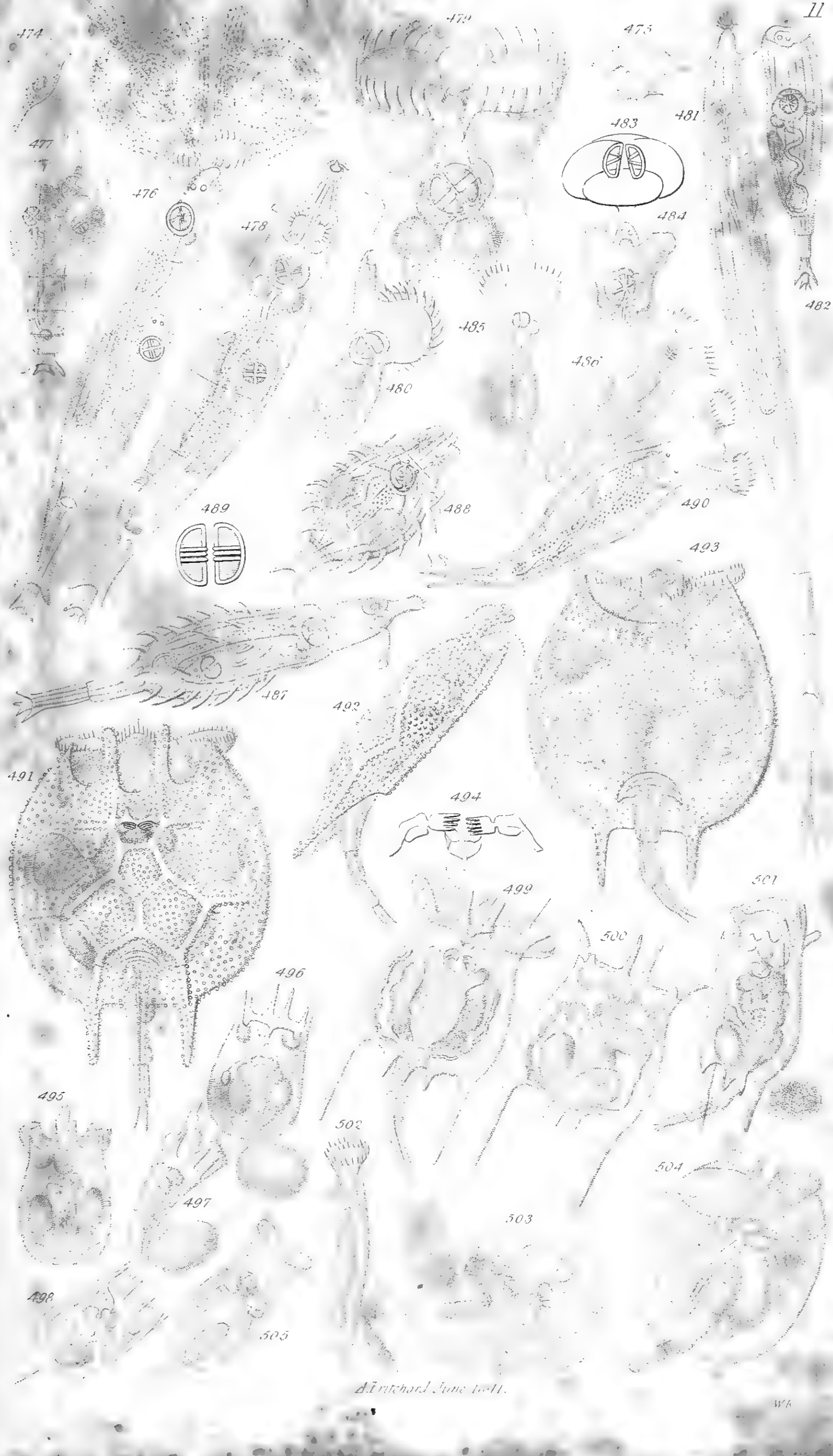
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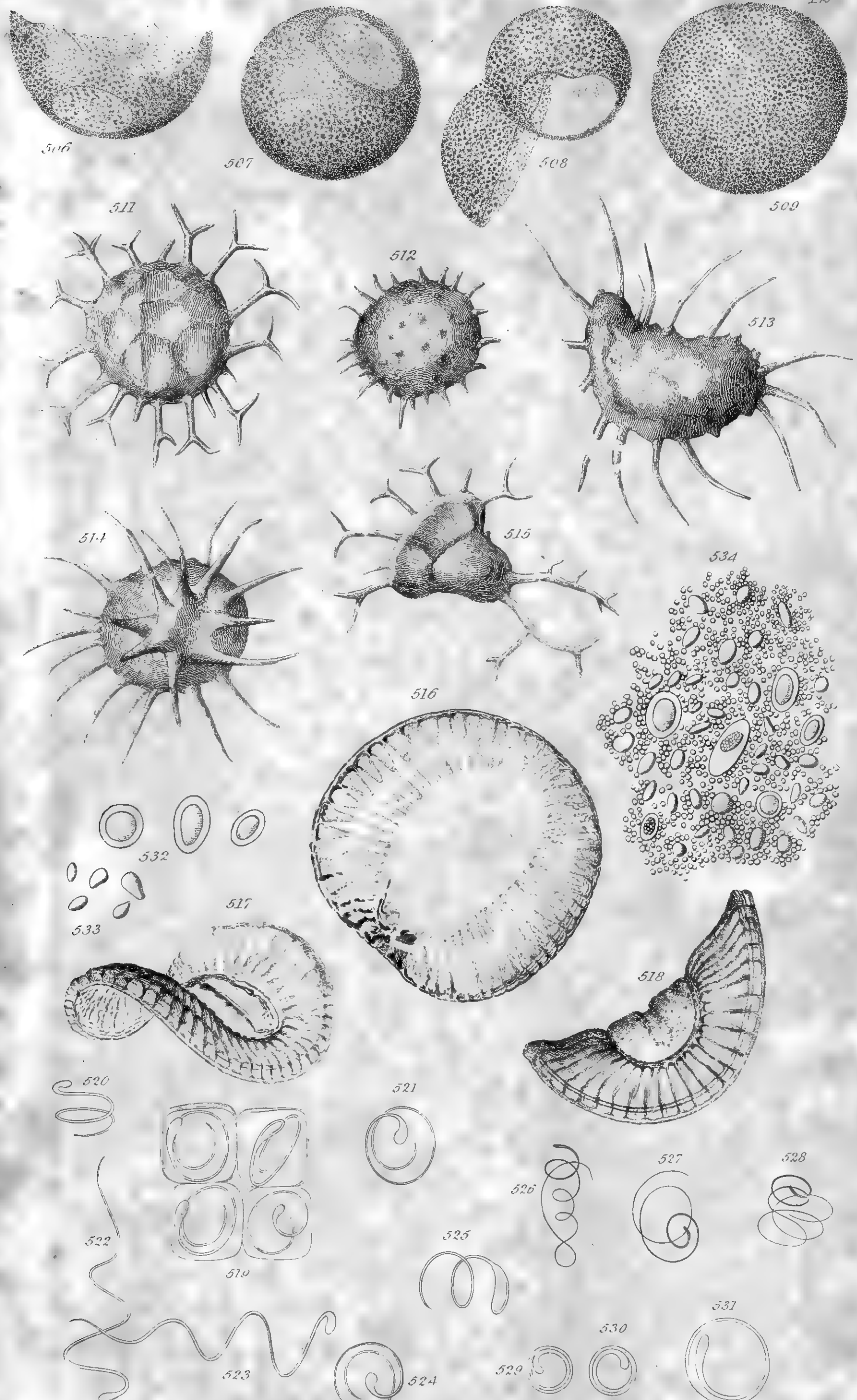

F. Bauer & Dr. Unger del. A. Pritchard June 1841. W. Kelsall s.